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ORIENTAL METHODS OF USING SOYBEANS AS FOOD

WITH SPECIAL ATTENTION TO FERMENTED PRODUCTS

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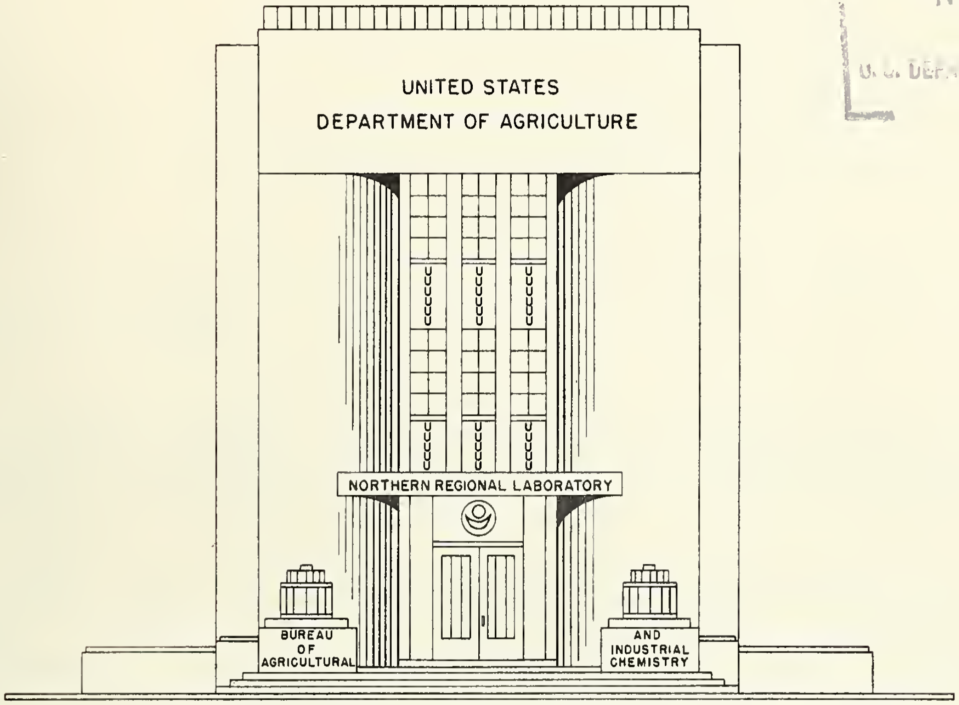

By Allan K. Smith

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PEORIA, ILLINOIS

JUNE 1949

ORIENTAL METHODS OF USING SOYBEANS AS FOOD

With Special Attention to Fermented Products. Notes on Oriental Farming Practices[1]

Allan K. Smith

PART I. CHINA

On a visit to China, Japan, and Korea during the summer of 1948, as a representative of the Northern Regional Research Laboratory, I was given the opportunity of studying the methods of Oriental people in using soybeans as food and to collect microorganisms used in fermenting soybeans and other fermentable products. Soil samples, as a source of new organisms, were collected for the Fermentation Division of the Northern Laboratory, and soybean seed samples were obtained for the Bureau of Plant Industry, Soils, and Agricultural Engineering. This trip also afforded me an opportunity to glimpse the customs and food habits of people who, because of the high density of population, have been forced to live on a vegetarian diet for centuries.

The localities visited were Shanghai, Peiping, Tientsin, Nanking, Hangchow, and Canton in China; Tokyo and vicinity in Japan; Seoul and Cheuju Do in Korea.

Information was sought from universities, experiment stations, oil processing companies, small and large food producing plants, and officials of the American Consulates General. Most of the information was obtained through the intermediate assistance of an interpreter.

This report deals separately with China, Japan, and Korea. Under China it includes the subjects of farming conditions, oilseed production, soy sauce, soybean or vegetable milk, soybean curd, soybean cheese, fermented soybeans, fen-t'iao from mung beans, vinegar fermentation process, and contacts and conferences. The Japanese section deals with Japanese agriculture with special reference to soybeans, production of miso in Japan, soy sauce, monosodium glutamate, and trends in soy sauce production. Korean agriculture and soybean food products are also discussed in collaboration with Dr. Raymond Culbertson, an agricultural adviser to the then newly formed Korean Government.

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[1] The text of this bulletin, with slight revisions, is as it appeared serially in THE SOYBEAN DIGEST, issues of February through June 1949, although many additional illustrations appear herein. It is processed with the publisher's permission.

Since the subject matter for each process was gathered from several sources, no attempt has been made to specifically credit the source of the material. The agencies previously indicated sought out small food processing plants and made advance arrangements for inspection of their operations. Many Chinese students who had visited the Northern Regional Laboratory were anxious to show appreciation for favors granted them while in America, and they extended me the well-known courtesy and hospitality traditional of China. In Japan, the Natural Resources and the Food Processing Sections of the Supreme Command of the Allied Powers furnished guidance and transportation as I sought information. A similar service was furnished in Korea by the Department of Agriculture and the Office of Property Custodian. Short trips into the country were made when feasible.

China had been at war almost continuously since 1937, and during that period many of her universities and research institutions were literally carried to the interior on the backs of her people. These institutions had returned to their original homes at the time of my visit and were attempting to carry on their intended functions. However, the current civil strife was a serious handicap to the progress of their scientific program as the expenditures for war prevented adequate support for research and other progressive activities.

Farming Conditions in China

In addition to many years of war, China's high density of population is a serious factor in preventing any rapid rise in her standard of living. Her traditional type of culture is a hinderance to much-needed population control; however, if given a few years of peace, China undoubtedly would make substantial technical advances which should be reflected in a limited improvement in her standard of living. In visualizing changes in China, it is important to remember that she is not now in a position to utilize much of the labor-saving equipment so common in the United States, nor to adopt many of our advanced technical developments. Changes in China must follow a pattern suited to her circumstances.

Agriculture is China's most important industry; nearly 90 percent of the people are farmers. There is much wasteland in hills, mountains, and deserts; roughly, only 25 percent of the land is arable. Farms average about 5 to 7 acres in size. If farmers of the wheat and corn sections of the United States were to visit China, I am sure they would be amazed at her farming practices.

In northern China the crops are similar to ours. They include corn, wheat, millet, soybeans, Kaoliang (sorghum), cotton, rice, vegetables, and some fruits; in southern China there is less diversification and the principal crop is rice. The great difference between our farming and theirs is in methods. Chinese farmers use hand tools; perhaps best described as like our garden tools. Figure 1 illustrates the method of cultivating soybeans in the Orient while figure 2 shows a Korean version of the turning plow. In northern China what little power they have, other than manpower, is furnished by small donkeys or oxen, while in central and southern China it is also furnished by the water buffalo. Figure 3 illustrates the

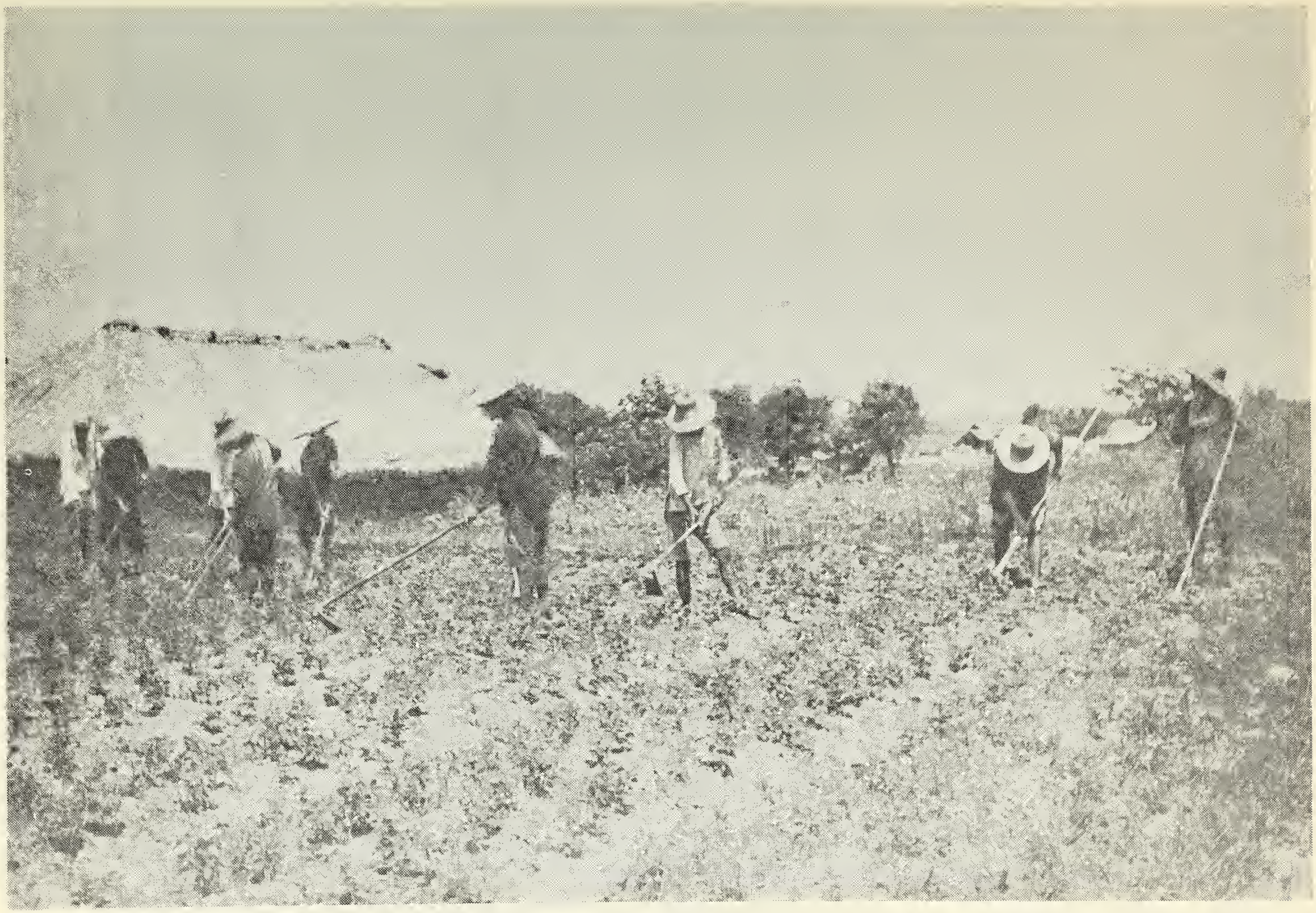

Figure 1.--Cultivating soybeans near Nanking, China. All of these workers but one are women. July 1948.

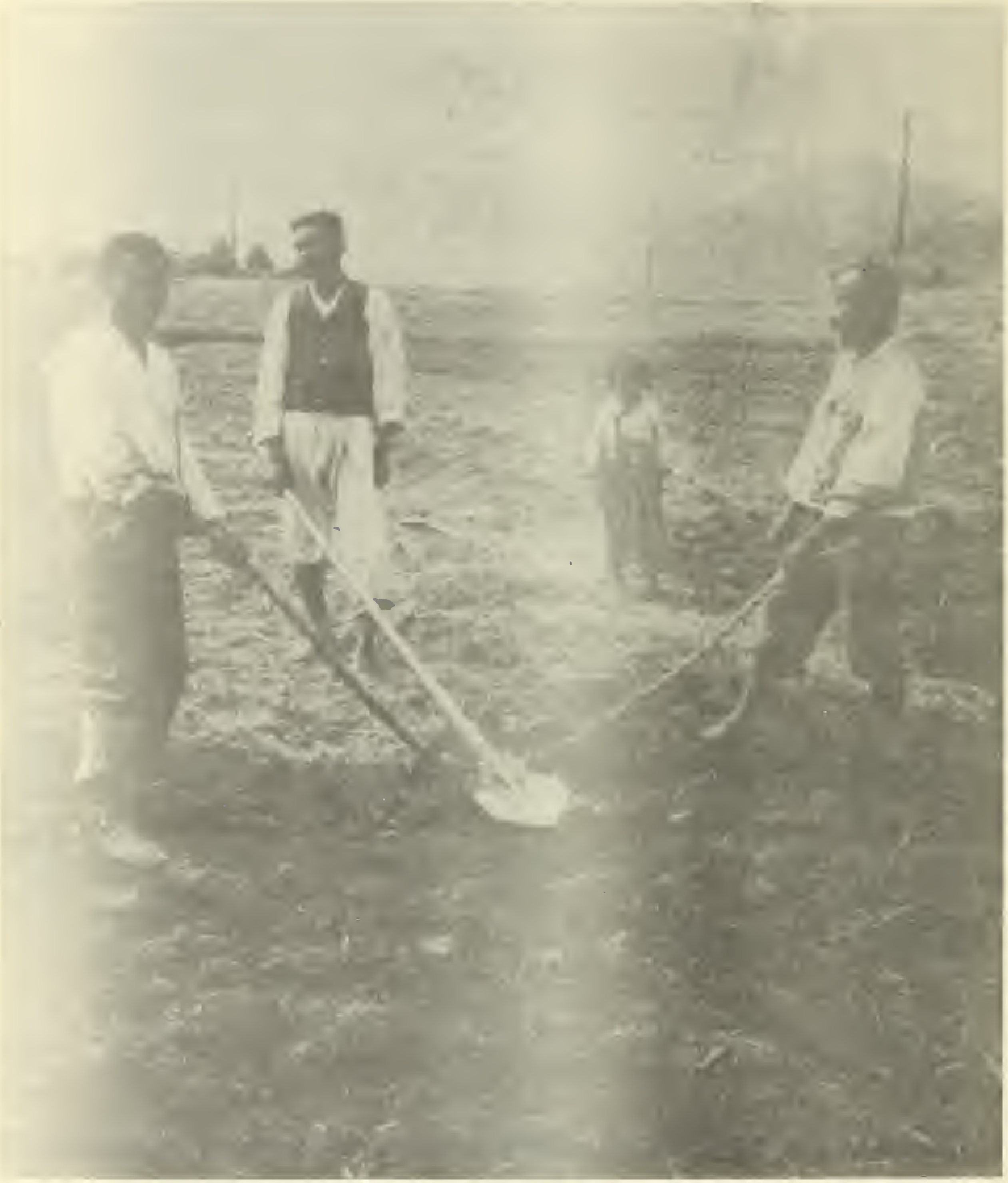

Figure 2.--A three-man shovel, Korean version of the turning plow. The motive power is supplied by the men holding the ropes.

threshing of wheat with a stone roller powered by a donkey, while figures 4 and 5 show methods of pumping water for irrigating rice fields. All parts of the equipment shown in figure 4 are made of wood. But there is a limited supply of animals for farm work, probably because of competition for food between the animal and man. There are many other simple devices for lifting water. Many of them are hand powered and the whole Chinese family works at irrigating and cultivating their few acres. Power machinery, as we know it, is not practical for them. China must import her gasoline and, therefore, its cost is prohibitive. Anyway, the Chinese farmer cannot afford a tractor. Even if given a tractor and the gasoline for its operation, a Chinese farmer would still find this equipment impractical because of the small size of his farm. Nevertheless, he could profit by a type of mechanization in keeping with his acreage. Just as the Japanese have developed a certain degree of mechanization adapted to their small plots, similar mechanization would be useful to China and further improvements are quite possible. Any release of labor from the farm through mechanization would, of course, need to be accompanied by industrialization to absorb the surplus labor and avoid unemployment. The Chinese farmer also could profit immediately by importation and development of new seed and varieties to replace those which have degenerated. Unfortunately, under present Chinese customs and practices an increase in production would probably go only to the support of a greater population rather than to an improved standard of living.

The high density of population in China dictates a vegetarian diet for most of the people, especially her peasants. I was informed by reliable authorities that customarily the peasants of China eat meat only three times a year, on their three great holidays, The Dragon Festival, the Autumn Festival, and at their New Year's celebration. The farmers raise some chickens, ducks, and pigs, and fish is common along the coast and waterways, but these products go largely to the few city people who can afford them.

According to Dr. William H. Adolph of Peking Union Medical College, the people of northern China use a basic food combination consisting roughly of 40 percent corn, 40 percent millet, and 20 percent soybeans. The northern diet also contains much wheat, some rice, and Kaoliang.

A comparison of the Chinese and American diets according to Dr. Adolph is as follows:

Food	Chinese diet	U.S.A. diet
	Percent	Percent
Meat and eggs	3.0	21
Fats and oils	4.0	10
Milk	0.1 (less than)	9
Sugar and starch		10
Vegetables and fruits	5.0	12
Cereals and legumes	88.0	38
	100.0	100.0

The division between animal and vegetable protein in the diet:

Animal protein	5.0	55.0
Vegetable protein	95.0	45.0

The diet in northern China, even though it is mostly vegetarian, is quite well-balanced because of the wide variety of cereals and oilseeds it contains. Those who eat this diet in sufficient quantity show no outward evidence of undernourishment.

In contrast, most of southern China is lacking in the dietary balance obtained by the use of a variety of cereals since its principal food is rice. However, the open market places of Canton show a remarkable variety of vegetables.

Dr. Adolph pointed out to me that the Chinese diet is much lower in calcium than the American diet, the difference being accounted for largely by the absence of cows' milk. The lower calcium intake of the Chinese people is not generally apparent in their physical condition and it has been suggested that their body systems have made a satisfactory adjustment to their available diet.

China gives a wonderful illustration of the effects on the human race of a vegetarian diet over a long period of time. In fact, the state of nutritional equilibrium which has been attained in eastern Asia on a vegetarian diet is unique and could no doubt serve as a source of valuable nutritional data.

The farmers I visited in northern China generally live congregated in small villages, which often are surrounded by a wall for protection. Many of the homes are built with mud or adobe which is reinforced with straw. The roofs are thatched. Floors are of dirt, and there is not much furniture. Neither wood nor coal for cooking or heating is available--the fuel consists of straw and other agricultural residues taken from the land. This practice, of course, robs the soil of much-needed organic matter which in our country is considered so important for good farming. Thus, it can be seen that the life of the Chinese peasant is rather primitive. Despite their primitive existence, Chinese farmers appeared to be rather cheerful individuals, although somewhat suspicious of strangers.

Oilseed Production

The 1947-48 production for seven major vegetable oils or oilseed equivalents for China and Manchuria, reported by Owen L. Dawson, Agricultural Attaché at the American Consulate General, was about 6.6 percent over the previous year, or a total of 3,543,000 metric tons. No reports were available on linseed, perilla seed, hemp seed, and castor seed.

While the 1947-48 oilseed production picture was better than for the preceding year, the current overall picture on oilseed supply was marred by the unsettled political conditions in Manchuria and northern China. The outlook on exports of oil and oilseed for the current year are pessimistic. Table 1 shows the production of vegetable oils and oilseeds for 1946 and 1947 compared with a prewar average for 1931-37. These data were taken from a report of the Agricultural Attaché American Consulate General, Shanghai, China.

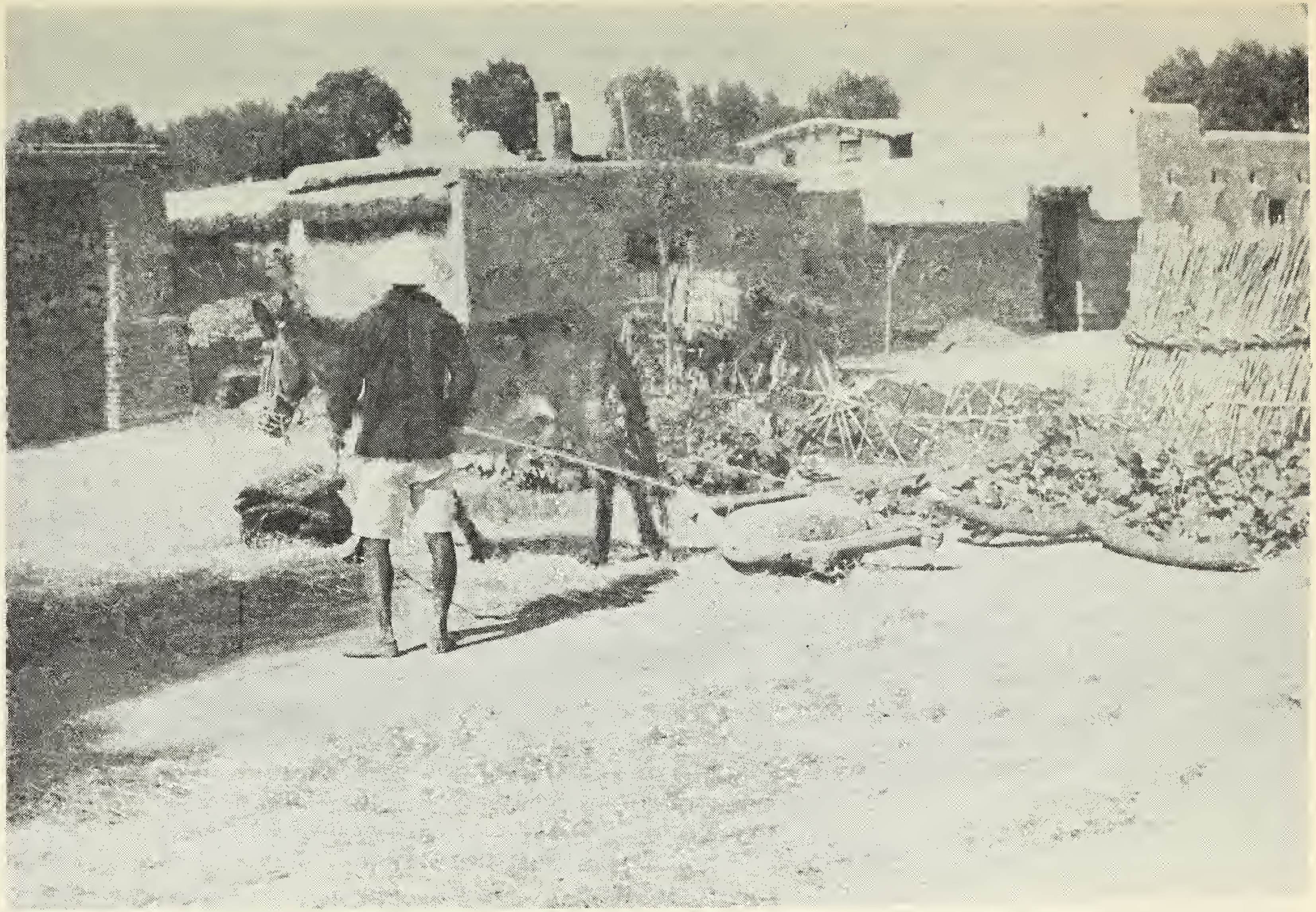

Figure 3.--Threshing wheat with a stone roller. Action of the roller forces the wheat berries from the heads, after which the straw is removed and the grain winnowed from the chaff. Near Peiping, China. June 1948.

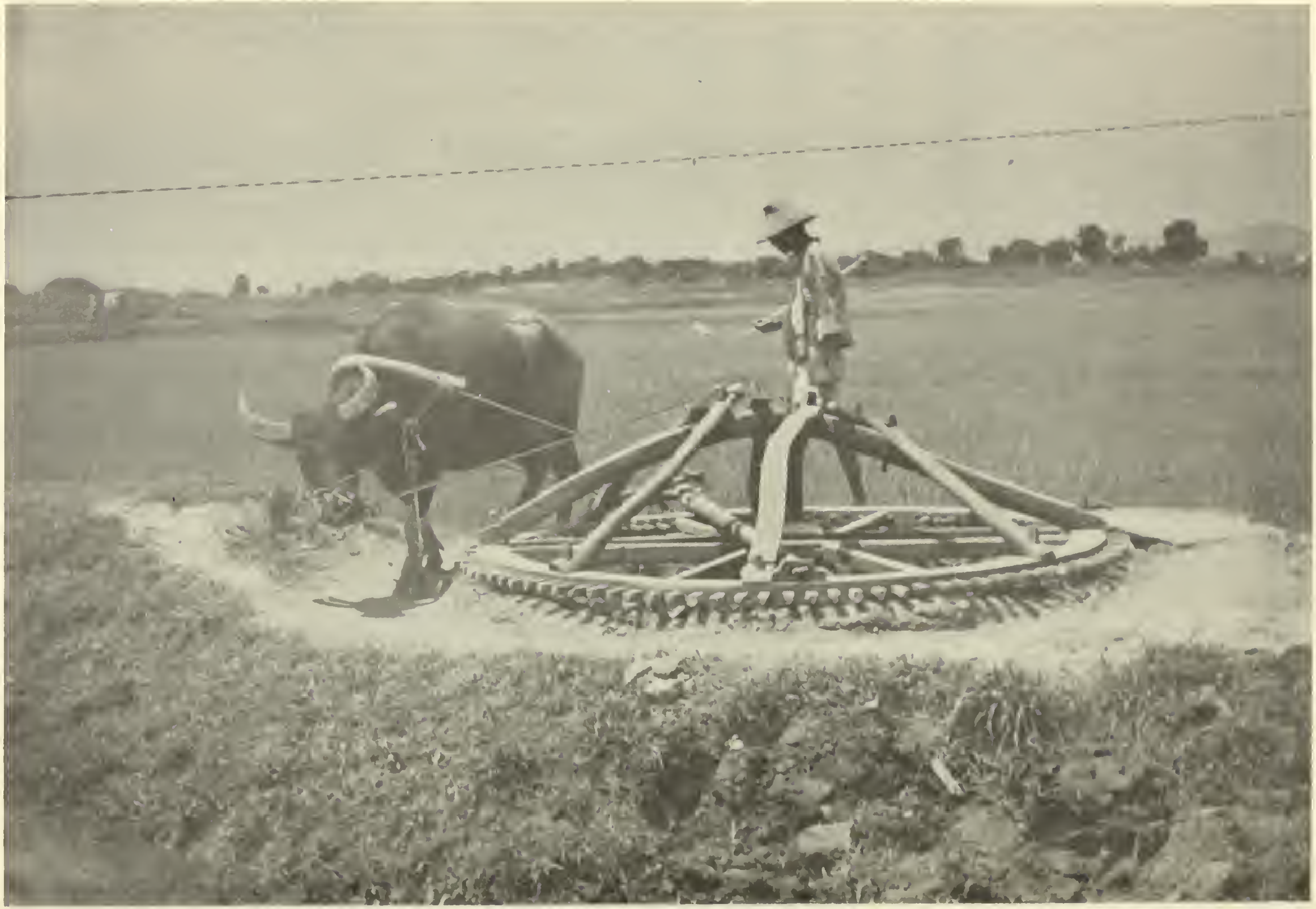

Figure 4.--Pumping water from the rice fields with a water buffalo. All parts of the pump and elevator are made of wood. Near Nanking, China. July 1948.

Table 1.- Production of vegetable oils and oilseed in China[1]

Item	Production					
	Average 1931-37		1946		1947	
	Seeds	Oil equivalent [2]	Seeds	Oil equivalent [2]	Seeds	Oil equivalent [2]
	Metric tons		Metric tons		Metric tons	
Tung oil	---	[3] 120,000	---	[3] 80,000	---	[3] 100,000
Soybean[4]	10,360,750	1,450,505	7,790,500	1,090,670	7,926,950	1,109,773
Peanuts[4]	2,849,400	712,350	2,210,450	552,613	2,231,750	557,938
Rapeseed	2,473,000	865,550	3,182,300	1,113,805	3,718,700	1,301,545
Cottonseed[4]	1,527,100	229,065	978,150	146,723	1,085,350	162,803
Sesame	873,000	392,985	695,900	313,155	643,550	289,597
Tea seed	---	25,000	---	25,000	---	21,000
Total		3,795,455		3,321,966		3,542,656

Other oilseeds of China not reported are linseed, perilla seed, hemp seed, castor seed, and oils from the tallow tree.

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[1] Source: Agricultural Attaché - Foreign Service, Shanghai.

[2] Oilseed converted to oil by following factors: Soybeans, 14 percent; peanuts, unshelled, 25 percent; shelled, 36 percent; cottonseed, 15 percent; rapeseed, 35 percent; sesame seed, 45 percent.

[3] Tentative estimates.

[4] Includes a rough estimate for Manchuria.

Soy Sauce in China

Soy sauce represents one of China's largest uses for soybeans. Soy sauce is used in the kitchen daily in the preparation of food and also as a table condiment. At most meals a dish of soy sauce is placed on the table and certain foods are dipped in the sauce for seasoning. The sauce is about 18 percent salt, hence serves as a salting agent as well as a flavor accentuator.

The soy sauce industry is made up largely of small plants which serve their own communities. There is no transportation of soy sauce from one town to another; in fact, it was discovered that to a certain extent farmers make their own supplies.

The largest Chinese soy sauce plant visited was one owned and operated by the Chang family with offices at 672 Peking Road, Shanghai. The plant covered about 6 acres. I estimated they were using 6,000 or more earthenware jars (each approximately of 50-gallon capacity) for soy sauce production. The Chang plant is the largest in Shanghai, and probably the largest in China. Most of the plants inspected were using 40 to 100 earthen jars. Two plants, one each at Peiping and Tientsin, built by the Japanese during their occupation of China, were being operated by their respective municipal governments. These Japanese-built plants followed procedures similar to those developed in Japan; their manufacturing processes were housed in semi-modern brick buildings, and the fermentation step was carried out in large cement tanks.

With the exceptions mentioned, making soy sauce in China is still done by the traditional methods, which have changed very little in the past few hundred years. The plants are family-owned and operated. In some instances the same family claims to have made soy sauce for 500 years. The microbiological and chemical processes involved in soy sauce production are, of course, very complicated and not well understood even by the best informed scientists. It is not surprising, therefore, that tradition rules in China and many plant operators claim that exposure of their product to the sun and even to the moon are significant factors in producing the best flavor and aroma. However, the shortage of soybeans and wheat in China is forcing a shift in some localities to the use of soybean cake in place of whole beans and to starchy materials other than wheat or wheat flour for making sauce. When wheat or wheat flour is unobtainable or too expensive, the Chinese are substituting wheat bran, oats, kaoliang, and rye. Barley is not favored. The different starting materials modify to some extent the flavor of the resulting soy sauce. It is preferred that the grain supplying the starch should be rich in this component and low in fiber.

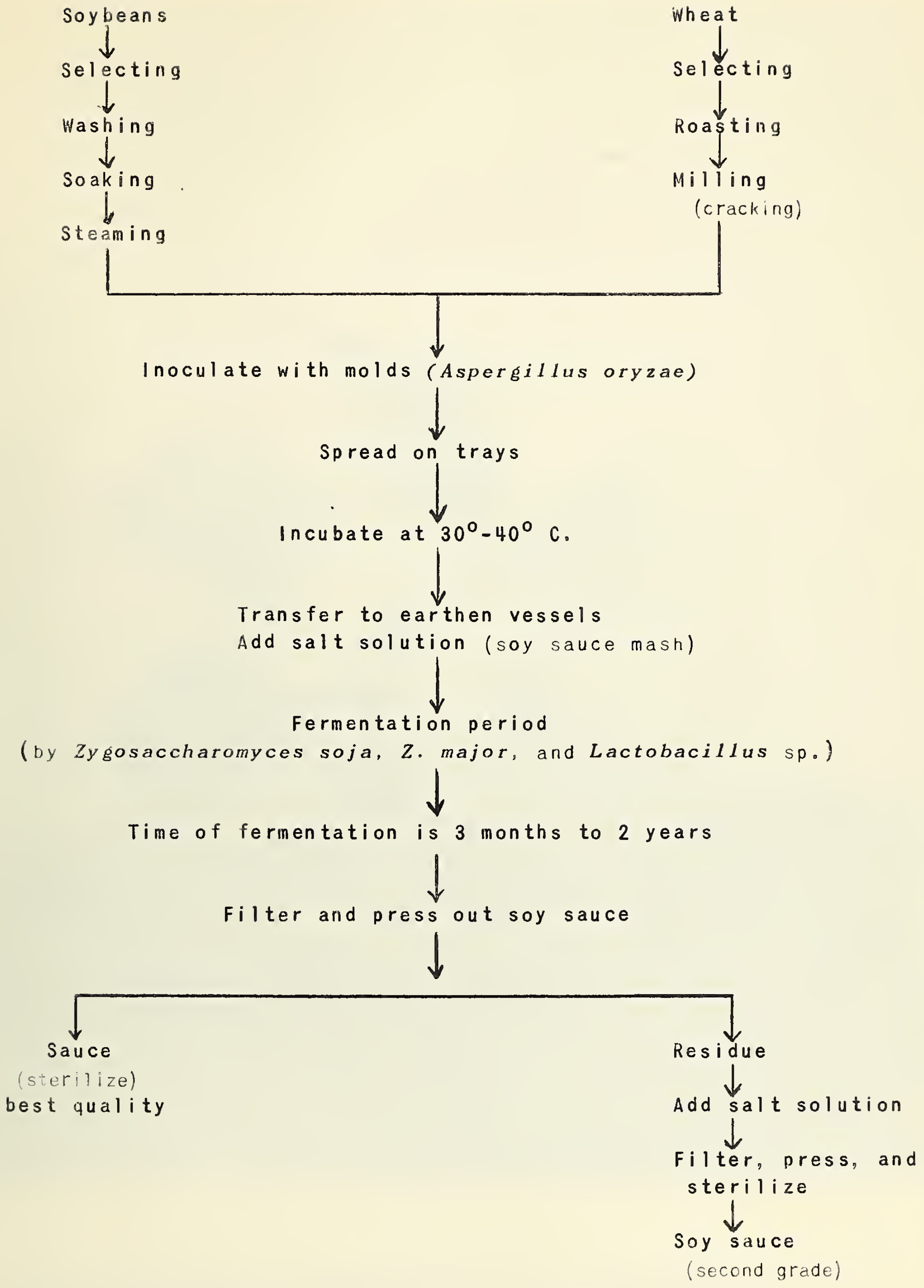
While there are several minor variations in brewing soy sauce, the accompanying diagram and the following description illustrate the process.

Brewing soy sauce is known to involve the action of molds, yeasts, and bacteria in that order. Some of the organisms which have been identified as important to the process are Aspergillus oryzae, Zygosaccharomyces soja, Zygosaccharomyces major, and Lactobacillus sp.

It is generally known that the starch is hydrolyzed by amylases to dextrins and sugars, and that the proteins are hydrolyzed by proteolytic enzymes to amino acids. The sugars are partly converted to alcohol and carbon dioxide and the alcohol may be further oxidized to acids. Most of the carbohydrates eventually are converted to acetic, lactic, butyric, succinic, and other organic acids. The simultaneous presence of alcohol and organic acids encourages the formation of esters, this probably accounting for the pleasant aroma of the sauce.

Sound whole soybeans are preferred for the process. They are washed clean and soaked in water. In summer it requires about 12 hours and in winter about 24 hours for complete wetting of the bean. The beans are next steamed, either at atmospheric pressure or, as in the more modern plants, under a steam pressure of 10 pounds per square inch. In the latter instance, the pressure is raised very slowly to the maximum and held there for an hour, then permitted to subside slowly to zero pressure.

FLOW SHEET OF SOY SAUCE PRODUCTION


Soybeans
Selecting
Washing
Soaking
Steaming
Wheat
Selecting
Roasting
Milling
(cracking)
Inoculate with molds (*Aspergillus oryzae*)
Spread on trays
Incubate at 30°-40° C.
Transfer to earthen vessels
Add salt solution (soy sauce mash)
Fermentation period
(by *Zygosaccharomyces soja*, *Z. major*, and *Lactobacillus* sp.)
Time of fermentation is 3 months to 2 years
Filter and press out soy sauce
Sauce
(sterilize)
best quality
Residue
Add salt solution
Filter, press, and sterilize
Soy sauce
(second grade)

This flow sheet of soy sauce production may vary in slight detail with localities and materials available, but in the main it covers all essentials of the Chinese method.

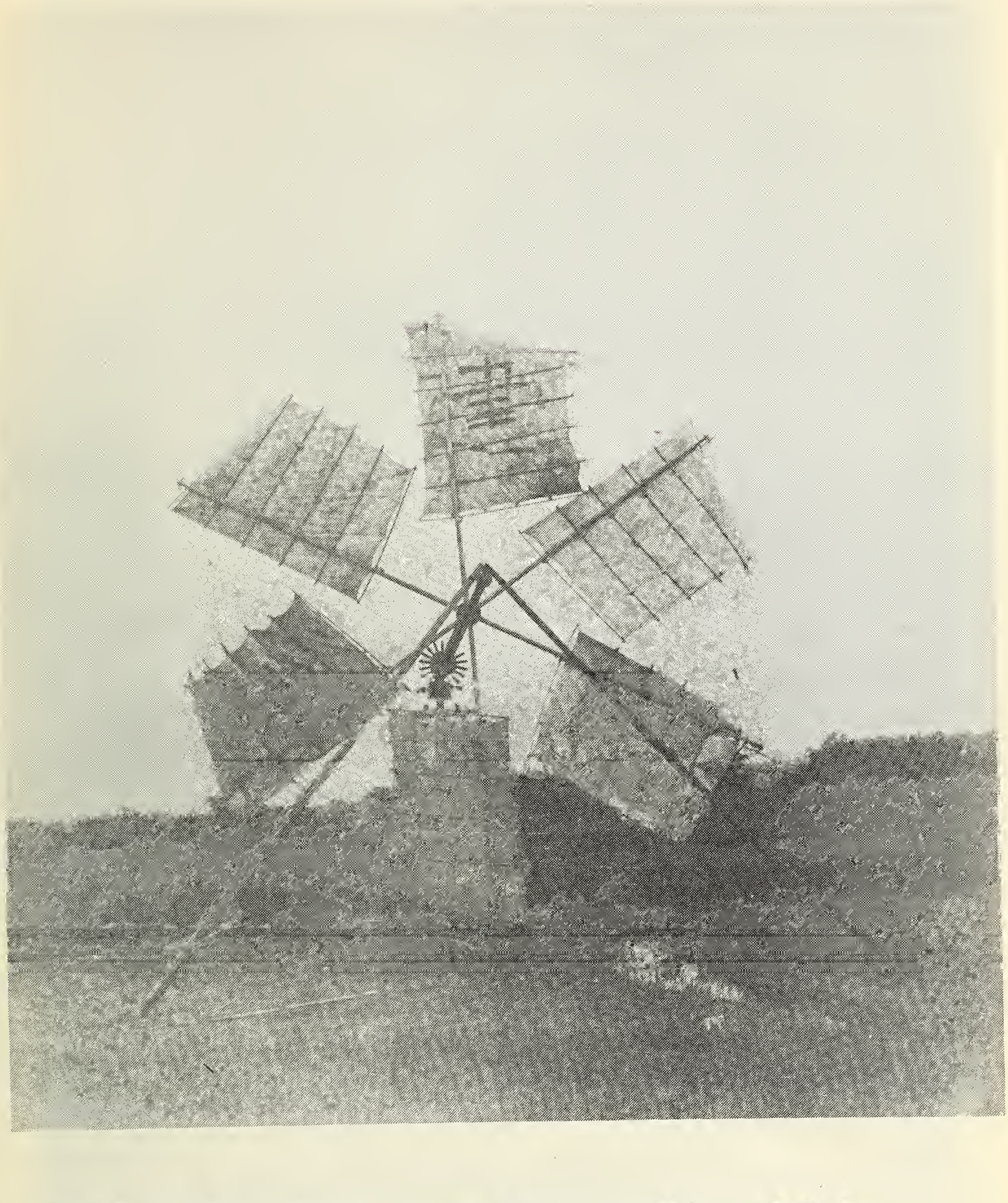


Figure 5.--Windmill used for pumping water. The sails or vanes are mats woven from grass. Near Shanghai, China. 1948.

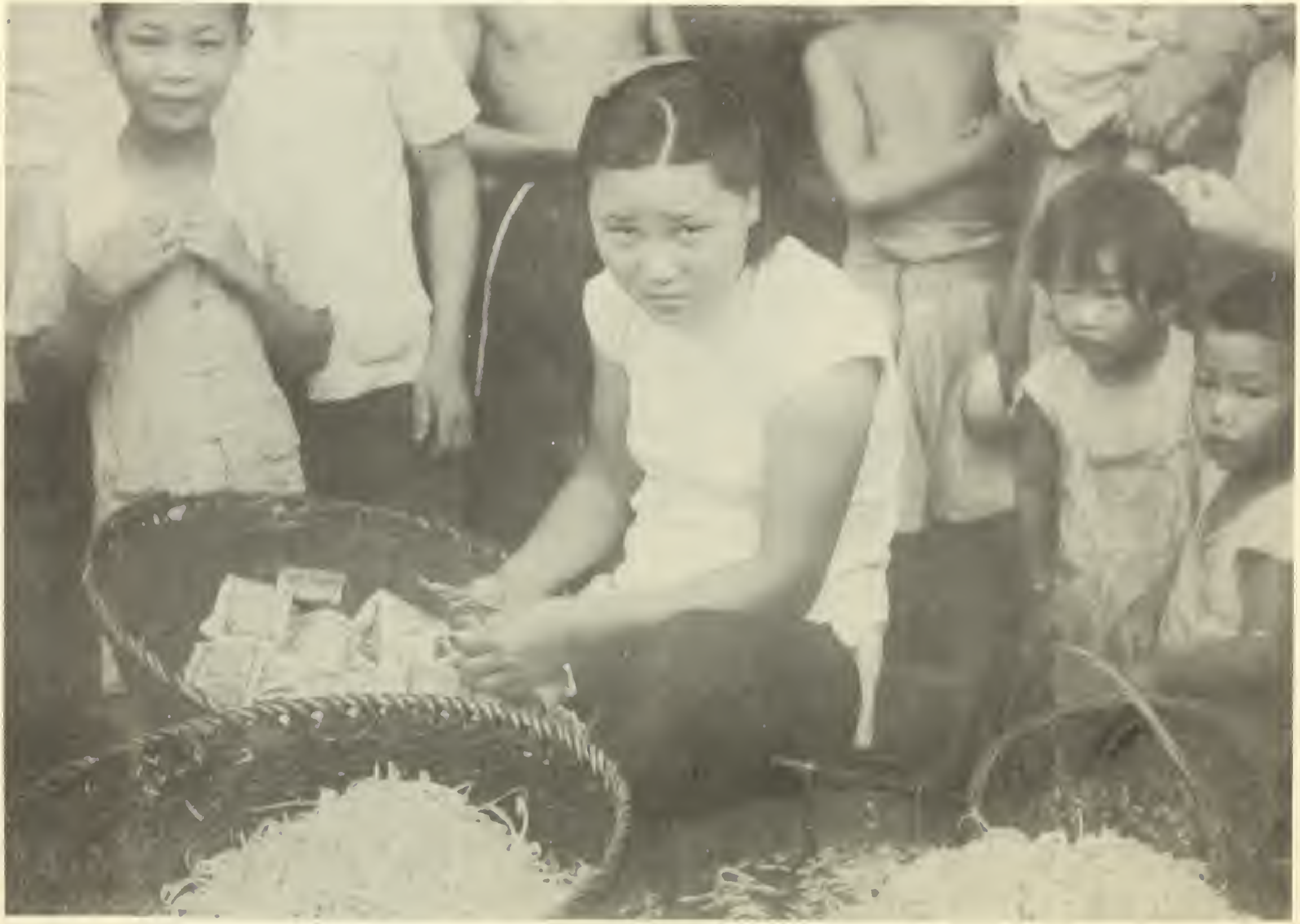


Figure 6.--Baskets of soybean sprouts and inflated Chinese national currency in the market place at Canton, China. August 1948.

The total time of steaming is about 12 hours. Figure 9 shows wooden tanks used in steaming soybeans. The tanks are usually located above a steam boiler.

After the steaming operation the beans are mixed with an equal weight (dry basis) of wheat that has been parched and cracked or with an equivalent amount of wheat flour, wheat bran, or other cereal grain. At the same time it is inoculated with a prepared Koji (culture) and placed in shallow trays where the mold is allowed to grow to the spore stage. The trays shown in figure 10 (woven of straw) are one of the many types used for growing the mold. In some plants the mold fermentation is carried out in a special room where the temperature can be controlled, roughly, around 30°-40° C. and a high humidity can be maintained. Under favorable conditions, 72 hours is required for proper mold development. Many small plants depend upon wild mold to start the fermentation and have no control over temperature or humidity. Under such conditions the initial fermentation may require a week or more for completion.

The molded material is then mixed in earthenware jars with sufficient salt solution so that the final product will contain 18 percent salt. The earthenware jars are kept out of doors in a courtyard where the fermentation process may continue for 3 months to a year or more. The contents of the jars are stirred every day in the early stages of fermentation. The jars are covered during rainy periods. Figure 11 shows the method used in China for fermenting the mixture of soybeans and wheat to soy sauce.

At most of the sauce plants it was stated that fermenting proceeded for 8 to 9 months, and they always insisted that the longer the fermentation period the better the sauce. However, many plants acknowledged that because of material shortages they were using only a 3-month fermentation period for much of their product.

When the fermentation is complete, the mash is placed in a filter press for removing the first grade of soy sauce. The residue is then extracted with salt water to obtain a second grade sauce. A third extraction may be made and used in subsequent operations.

The composition of several different soy sauce products are shown in table 2. The samples include (A) the sauce and analysis from National Central University at Nanking, China; (B) analysis by public analyst of soy sauce from the Kikkoman Shoyu Company Limited, Noda City plant, Japan; (C) and (D) Chinese soy sauce samples from the "old process" (1 year) and the "quick process" (3 months), respectively, furnished by Dr. Pei-Sung King and C. T. Siao of the National Bureau of Industrial Research, Shanghai, China, and the analysis by the Analytical Section of the Northern Regional Research Laboratory.

The high salt concentration is required to inhibit the action of undesirable microorganisms and to preserve the soy sauce, however, it also has the detrimental effect of slowing up the action of the desirable organisms and imparting a too salty taste to the sauce.

Table 2.- Analysis of four representative soy sauce samples

Item	Sauce A Chinese Nanking	Sauce B Japanese Noda	Sauce C Chinese Old process	Sauce C Chinese New process
	Grams per 100 milliliters			
Total solids	32.0	38.13	29.7	30.5
Mineral matter		19.70	20.2	16.4
Sodium chloride	16.0	18.02	18.8	14.0
Phosphoric acids (as P_2O_5)		0.48		
Total nitrogen	1.0	1.51	0.76	1.01
Protein nitrogen		0.09		
Nonprotein nitrogen		1.42	.72	1.00
Amino nitrogen		0.70		
Volatile acids (as acetic)	0.5	.14		
Nonvolatile acids (as lactic)		.65		
Total acidity	.7		4.1	5.3
Sugar (as glucose)	2.0	5.99	3.06	6.74
Dextrins		1.06		
Total carbohydrates (as glucose)			4.2	9.6
Viscosity[1]		4.84	3.04	4.18
Hydrogen ion concentration--pH		4.6	4.6	4.9
Hydrogen ion concentration (10 times diluted)			4.9	5.2
Specific gravity 15° C.	1.2	1.2	1.195	1.19

[1] Sample (B) by Ostwald at 25° C., (C) and (D) by Hoeppler viscometer at 30° C.

In China no standard of composition or method of preparation of soy sauce was found. Quality is determined by flavor. In Japan the standard sauce is supposed to contain 1.5 grams per 100 milliliters total nitrogen as in sample B (table 2). Because of material shortages, sauce is now being produced at half of this nitrogen concentration. The salt content, however, is maintained at 18 grams per 100 milliliters.

In China, after the sauce is filtered it is usually sterilized at 65° C. for 30 minutes. Significantly higher temperatures are avoided because they cause flocculation of some components. After this sterilization, coloring matter, condiments, and preservatives are sometimes added. The most common coloring matter is caramel; licorice or maltose may be added as a sweetening agent; and in some places a special sweetening agent is made from millet which is known as "millet jelly." The millet jelly is about 50 percent maltose and 50 percent other carbohydrates. Spices such as cloves, nutmeg, pepper, cinnamon, ginger, allspice, and other condiments with names which could not be translated into English, are frequently added to the soy sauce. The best grade soy sauce, however, does not ordinarily contain condiments.

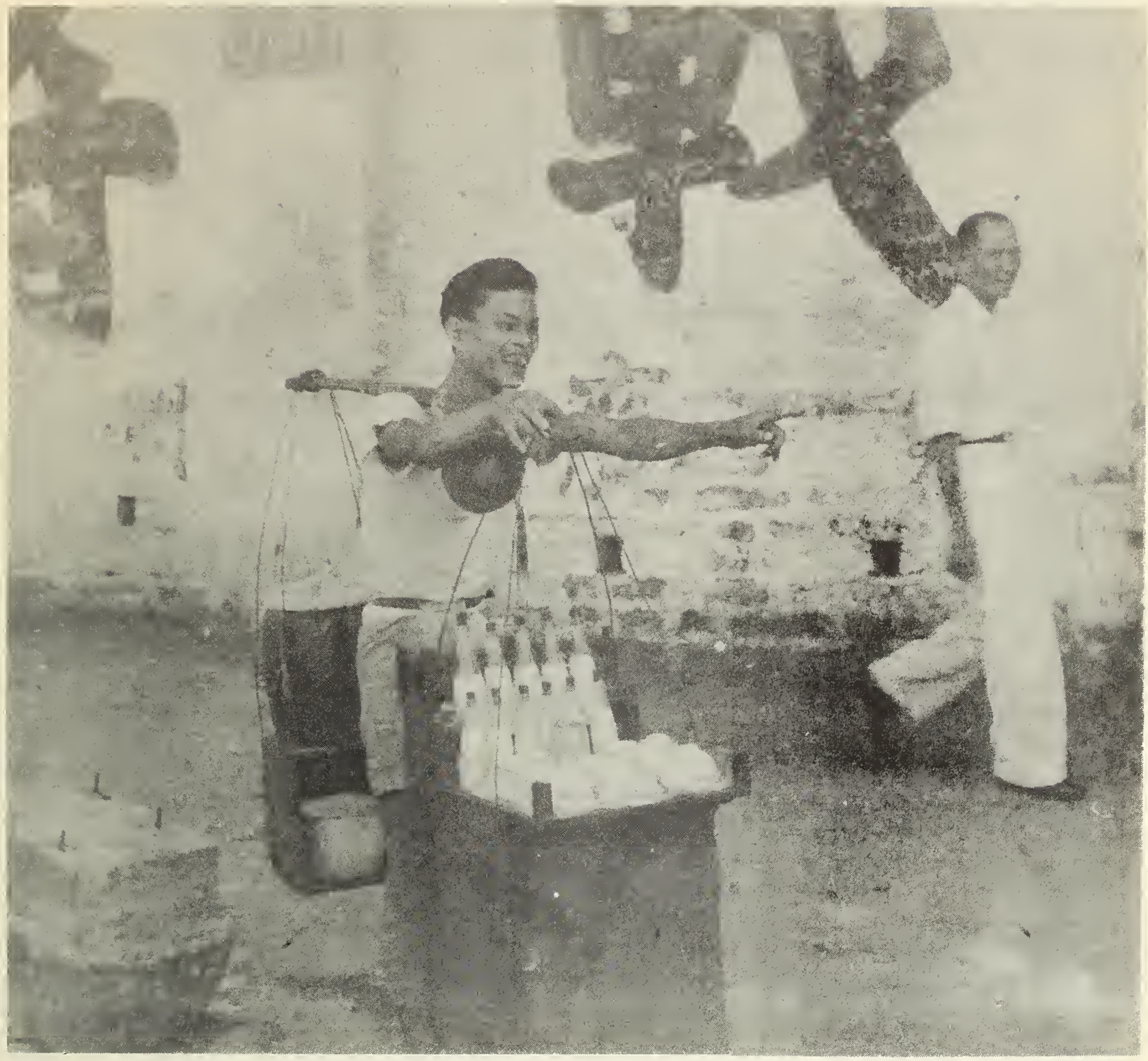


Figure 7.--Soybean milk for sale on the streets of Canton, China. August 1948.

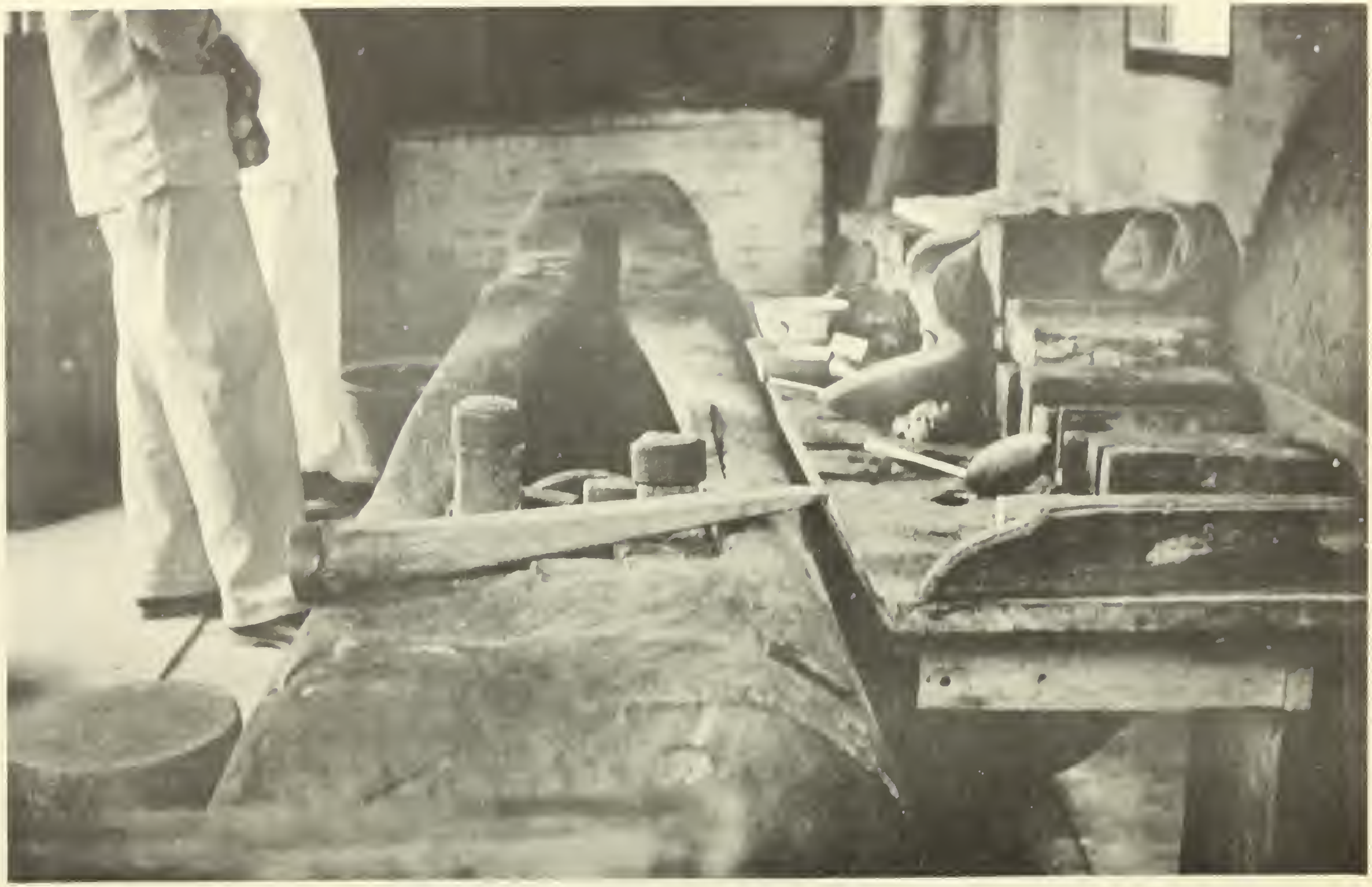


Figure 8.--A wedge press for oilseed operations, at Canton, China. Preformed disks of the flaked or ground meal are inserted in the slot, turned crosswise in the hollow log, and pressure applied with wooden wedges. July 1948.

The addition of condiments after sterilization would appear to cancel out the previous sterilizing process, since some of the condiments are known to be heavily infected with microorganisms.

A few soy sauce plants add preservatives such as sodium salicylate or beta-naphthal to their final product.

Sweet Flour Paste--Tien Mien Chang

"Sweet flour paste" was found only in Peiping, China, although it is probably produced elsewhere. The raw material for this paste is steamed bread, a wheat-flour product.

In making Tien Mien Chang, steamed bread is laid on sorghum stalks in a shed which ordinarily has one open side. The operator for this process stated that it was not successful if the sorghum stalks were replaced with bamboo or other materials. Grass mats are lowered over the open side of the shed and the bread allowed to mold for three weeks. Considerable heat is evolved during fermentation and the temperature is roughly controlled by spraying water over the shed and by means of ventilation.

The fermented bread is placed in earthenware jars in an outside courtyard with 5 percent salt and a very little water. An additional small amount of water is added each day during the early part of the fermentation period, but this part of the operation was not fully disclosed--the operation was a trade secret supposedly known only to this family. The paste is stirred several times each day while the fermentation continues for 6 to 8 months. The making of sweet flour paste usually is started in May of each year.

Soybean or Vegetable Milk

Soybean milk is a product closely associated with soybean curd or Tofu, since the initial steps in making them are the same. Both are food products in common use throughout China, Japan, and Korea. Soybean milk and curd are as unstable as cows' milk and, therefore, are prepared fresh each day and sold on the street or in small food shops.

While any variety of soybeans may be used to make bean milk or curd, certain varieties such as the "eighth month white bean" or "water white bean" are preferred varieties.

To prepare the milk, the beans are thoroughly washed and in summer are soaked in water 6 to 7 hours, in winter 24 hours. The beans are then ground in a stone mill with cold water. The stone mill is powered usually by a small donkey or by hand. The ratio of water to beans is about 10 to 1, although this ratio may vary somewhat. The crushed mass is filtered through a cloth and pressed to remove as much of the liquid as possible. In the most advanced methods, salts, sugar, oil, and vitamins may be added to obtain a balance of the constituents comparable to that found in cows' milk; and the milk is boiled for as much as 30 minutes and is sold on the streets in bottles as shown in figure 7. Considerable protein is left in the residue which goes for animal feed.

Numerous experiments, especially in camps for refugee children, have demonstrated that soybean milk can be prepared in a highly nutritious form although it usually has a characteristic soybean flavor that is not too popular even with the Oriental people, and this is probably the reason it is consumed mainly by the poorer people.

The China National Government has taken an active interest in soybean milk for use by its army. Mr. Willis Miller, with offices and business connections with the Henningsen Produce Company in the Dollar Building (7th Floor) at 51 Canton Road, Shanghai, had just completed, at the time of my visit, the building of a soybean milk plant for the Chinese Government. The process is patterned after that of the International Nutrition Laboratories at Mt. Vernon, Ohio, for making a powdered or spray-dried milk. Mr. Miller also was supervising the installation of a vegetable canning plant for the same purpose.

Yuba: If soybean milk is heated to boiling a protein film will form on the surface. This film may be removed with sticks, hung on a line and dried to form a yellow colored sheet. The product is known as Yuba. When dry, the sheets are brittle. The Yuba in sheet form may be used as a wrapper for other foods, or broken into smaller pieces or cut into ribbons and fried or used in soups.

Soybean Curd or Tofu

Soybean milk may be used directly for making Tofu or, if preferred, a few sheets of Yuba may be removed before precipitating the curd. The curd is usually precipitated from hot milk with a magnesium or a calcium salt. It appears that some shops, for economic reasons, use a mixture of salts that are left after removing sodium chloride from sea water. Since the Chinese diet is low in calcium, it is apparent that the most desirable precipitant would be a calcium salt. The type of salt and temperature of precipitation are factors which markedly influence the coarseness and other physical properties of the curd. For 133 pounds of soybeans about 6 pounds of gypsum is recommended for precipitation. The curd is allowed to settle, then filtered into a cloth and the cloth with the enclosed curd is placed in a wooden frame for pressing. Pressure is applied over a period of time by any suitable means to reduce the water content of the curd and give it a consistency satisfactory for cutting into small cubes as illustrated in figure 12. It is then ready for sale or fermentation into various types of cheeselike products.

One of the most popular methods of using Tofu is to add it in small squares to soup. It is used extensively in the Buddhist restaurants as a meat substitute; in fact, they prepare the curd to look like breast of chicken, roast of pork, and other meat and fish dishes. One restaurant prepared more than 25 different dishes from soybeans; the Chinese names of most of these dishes have no English equivalent. The curd, which has little flavor, may be fried in various types of sauce, made with egg into an omelet, cooked with meat, smoked, or fermented.

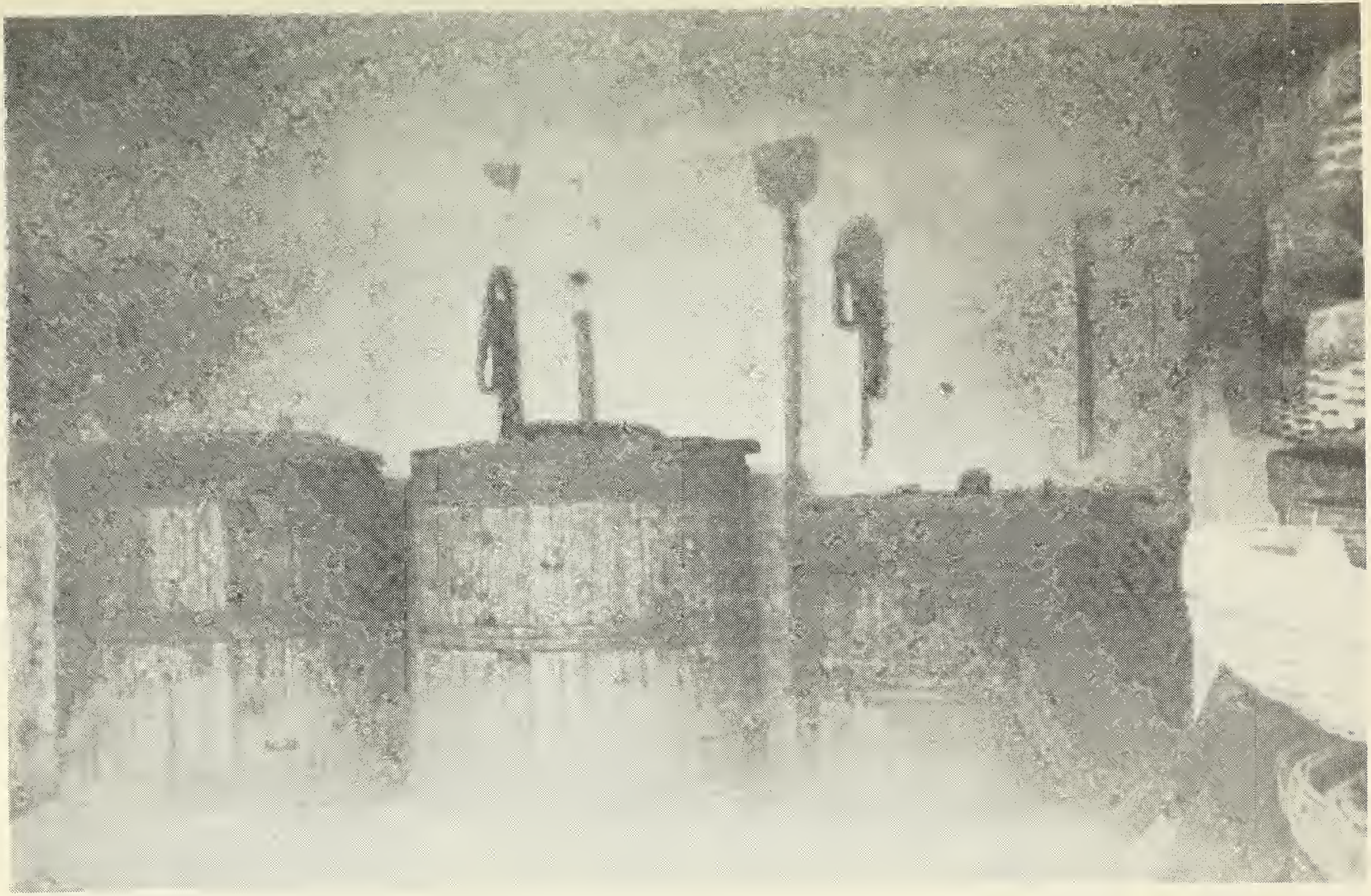


Figure 9.--Equipment used for steaming soybeans preparatory to making soy sauce. Steam is passed upward through the wooden tanks from a boiler underneath. Peiping, China. 1948.

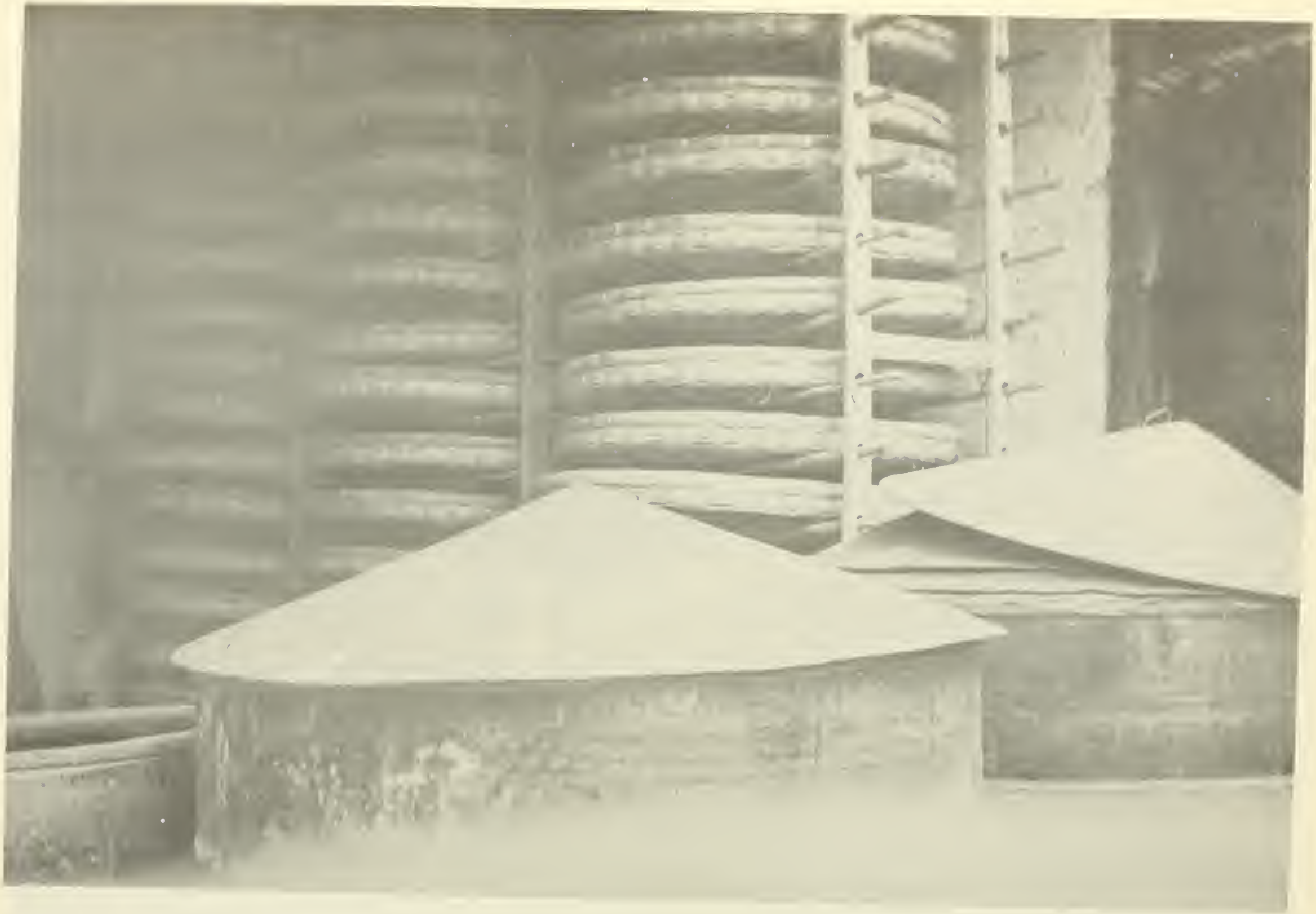


Figure 10.--Soy sauce preparation. Steamed soybeans are placed in woven baskets or trays for 3 to 7 days to permit growth of the mold, *Aspergillus oryzae*. Nanking, China. July 1948.

Soybean Cheese

Soybean curd, previously described, is the starting material for making all types of soybean cheese. In making the curd it is pressed hard enough so that it can be cut into small cubes, these varying in size for different cheese preparations. Significant variations in the processes, besides the microorganism, are the proportion of salt and type of solution in which the cheese is aged. The cheese appears to vary somewhat with the locality in which it is produced, a variation due probably to the influence of climatic conditions on the activity of the fermenting microorganisms.

At Hangchow they make a cheese product known as "Chee-fan," "Chee" meaning cheese and "fan" meaning small cube, hence a literal translation is "small cheese cube." This type of cheese was reported to be made in only two localities, Hangchow and Shoshing, the home of the famous Shoshing wine.

Chee-fan is a brownish soft cheese. It has both an agreeable smell and taste. The following materials and proportions are recommended for making this cheese.

Material	Chinese weights	Metric weights
Soybeans	1 za	70 kilograms
Salt	50 kins	25 "
Yellow wine (Shoshing)	70 "	55 "

In making the cheese the pressed soybean curd, prepared from the recommended amount of beans, is cut into cubes about 1/2 by 1/2 by 1/4 inches. The cubes are inoculated with mold, salted, and placed in an appropriate storage house for about 7 days for development of mold, as illustrated in figure 13. The mold (*Mucor*) is grown on wheat flour. It exists in Chinese mold of wine and is white in color. Also, *Aspergillus glacus*, blue in color, apparently takes part in the cheese development. The cubes are next placed in an earthen crock or wide-mouth bottle of about 2-gallon capacity, and yellow wine and mold of wine are added. It is allowed to age in the wine for about 1 year.

Ts̈ue-fan is another type of cheese. Its name, translated literally, means "drunken cheese." The name probably reflects the use of wine in making the cheese. The materials and proportions for this cheese are:

Material	Chinese weights	Metric weights
Soybeans	1 za	70 kilograms
Salt	30 kins	15 "
Wine	70 "	35 "

The pressed soybean curd, cut into cubes 1 1/2 by 1 1/2 and 1/2 inches, is boiled in water, cooled, and partly dried. It is molded and placed in yellow wine (rice wine) with wine mold added and aged for 6 months.

Hon-fan is a red cheese, with soy sauce entering into its preparation. The materials and their proportions are:

Materials	Chinese weights	Metric weights
Soybeans	1 za	70 kilograms
Salt	60 kins	30 "
Soy sauce	20 "	10 "
Red mold (from Foochow)	1.5"	.75 "

This cheese is made in the same manner as "drunken cheese" except that soy sauce rather than wine is used in aging the cheese. It was reported that red cheese is made only in the fall of the year.

Fen-T'iao From Mung Beans

Fen-t'iao or Fentiao is a string-like product somewhat resembling spaghetti in physical appearance but its chemical composition is mainly protein rather than carbohydrate. Fen-t'iao translated to English means "flour string," and is made from the "green bean" or mung bean.

In preparing fen-t'iao the beans are cleaned and soaked in water 10 to 12 hours. They are then ground to a paste in a stone mill and water is added to three times the original volume. The mash is then put through a sieve to remove hulls and other coarse fibrous particles which are discarded. After the mash settles, the supernatant solution is removed, first by decantation and then by filtering and draining in a cloth bag, and discarded.

The most important step in making fen-t'iao is kneading the proteinaceous material. Kneading is supposed to determine the quality of the product. In China kneading is a hand operation lasting 2 to 3 hours. At the start, a small portion of the proteinaceous material is dipped in warm water for a few minutes and the kneading operation begins, then additional quantities of the protein are added until the whole batch is kneaded together. The temperature of the operation should be about 37°-40° C. and if the best results are obtained, the fen-t'iao becomes transparent.

To convert the dough mass into strings, it is forced by hand through holes in a copper sieve-like affair and allowed to fall into a kettle of boiling water placed about 2 feet below the extruder. The diameter of the strings, as they come from the sieve is about 1/2 inch, but this diameter is reduced to about 1/16 inch by stretching. The protein appears to be either coagulated or denatured by the hot water.

In the final operation the fen-t'iao is cooled with cold water, cut into lengths of about 2 meters and hung on bamboo supports for drying. It may be artificially colored if desired.

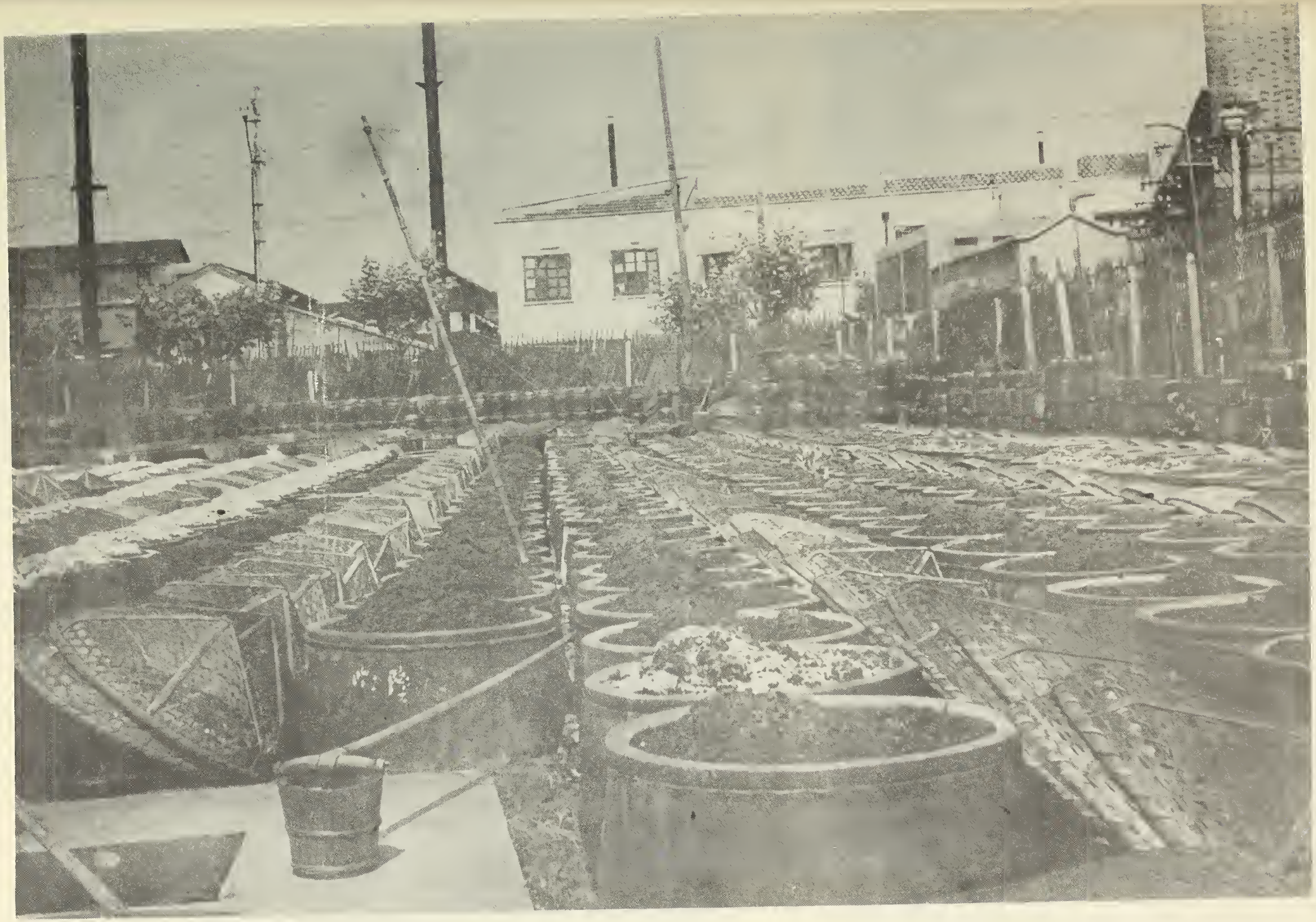


Figure 11.--Soy sauce production. Following the growth of a thick mold on the soybeans, they are mixed with parched and cracked wheat and Ferplaced with salt solution in earthenware jars for fermentation. Fermentation lasts 3 months to 2 years. Soy paste is fermented in a similar manner but it contains less water and the fermentation period is about 3 months. Shanghai, China. August 1948.

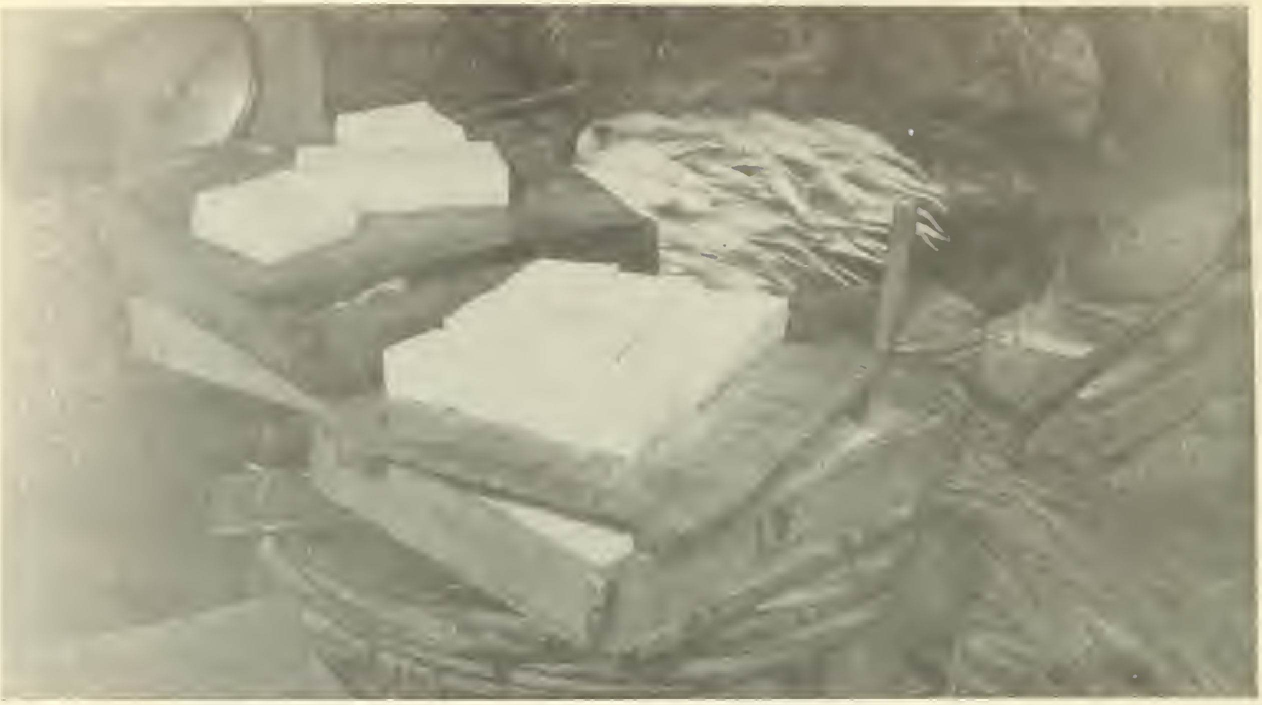


Figure 12.--Soybean curd and vegetables displayed for sale in market place, Seoul, Korea. August 1948.

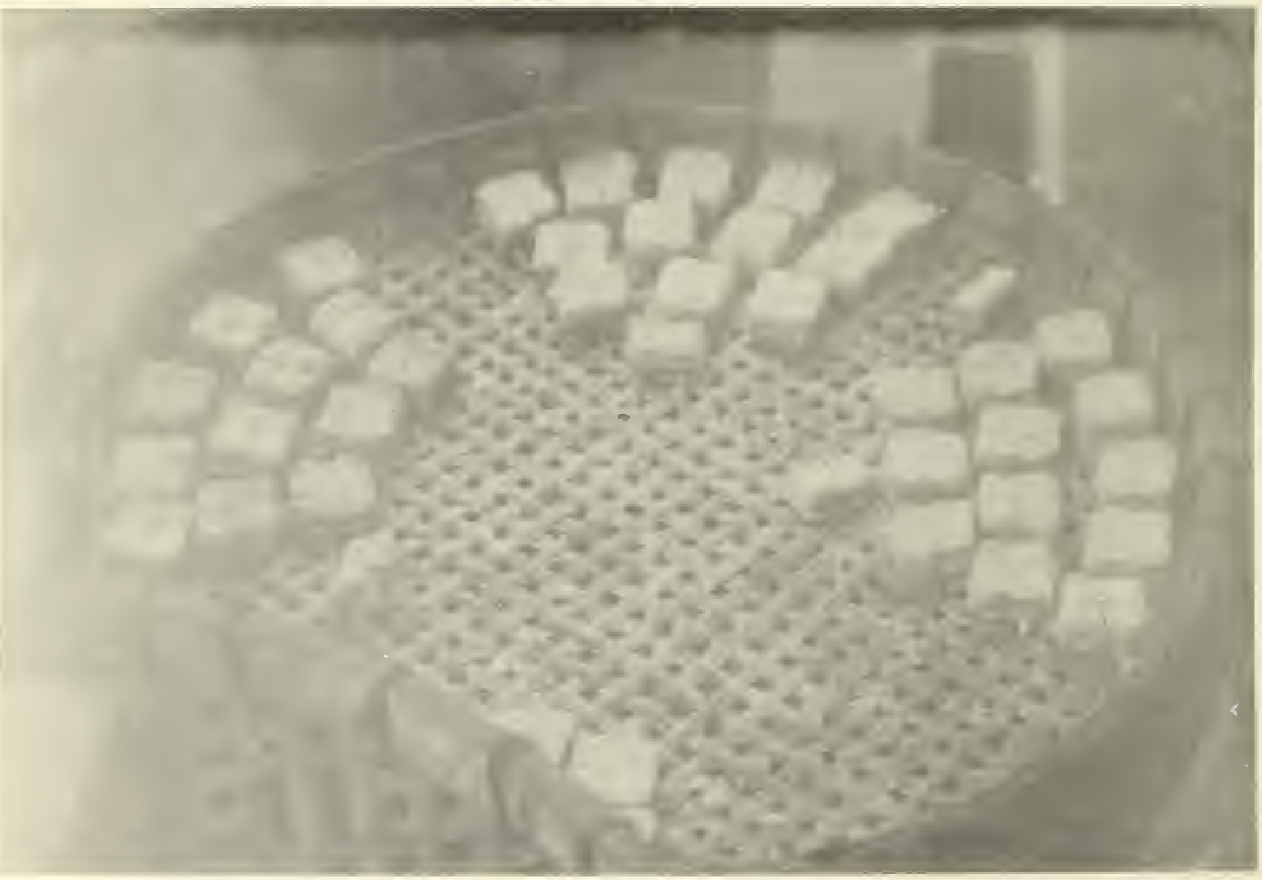


Figure 13.--Soybean curd with white mold. This is the first step in making soybean cheese. Canton, China. August 1948.

Fen-t'iao is used in soups or mixed with vegetables, usually with vegetables that are prepared by boiling.

Fermented Soybeans

Small black soybeans are used for this particular product which is a delicious appetizer with a characteristic flavor similar to that of soy sauce. In preparing the fermented beans for table use they are usually soaked in water for an hour and cooked with vegetables or meat. The period for fermenting the beans is between October and April.

For the fermentation process, sound whole beans are cleaned and soaked in water for 24 hours and steamed for 5 hours at atmospheric pressure. The beans should be soft but not mealy.

The steamed beans are spread on trays about 1/2 inch deep and inoculated with Mucor sp. and placed in room of constant temperature of 30° C. and of high humidity. They are incubated 7 to 15 days, depending on the conditions in the room, and the chief fermentation takes place at this time.

The fermented beans are next transferred to an earthen jar and sealed. The jars are aged 6 months or longer but not more than 6 years. Some further fermentation takes place during this period and the flavor and taste improve with aging. The product may now be seasoned and packed in tins or paper cartons. The seasoning for 150 pounds of beans may consist of 14-15 lbs. of salt, 1/2 to 1 oz. of spices, and 4-8 ozs of wine or whiskey. The above process was described by Hi-Lieng Lin, Department of Agricultural Chemistry, National Central University, Nanking, China.

Vinegar Fermentation Process

The persons operating the vinegar plant at Peiping spoke a Chinese dialect different from that of my interpreter, thus some language difficulties were encountered in obtaining a description of the vinegar fermentation process.

The raw materials for making vinegar were millet (apparently two varieties), wheat bran, and rice hulls. Rice hulls were used, probably to prevent packing of the millet and wheat bran and to allow some circulation of air in the system. A special yeast is used to start the fermentation. The fermentation was started in a shed which also housed a mule next to the fermenting vat. The shed was very dirty and afforded opportunity for a considerable variety of contamination.

The ground raw materials are placed in a fermenting vat or barrel of about 50-gallon capacity with a generous amount of yeast or starter, but with only water enough to moisten the grain. The fermentation proceeds rapidly and the bottom of the barrel becomes quite warm. To prevent overheating of the mash, it is transferred to another barrel and salt is added. The transfer of the materials serves also as a means of mixing the batch. The salt added was measured as "three dishes," which I estimated as between 6 and 9 pounds for the 50-gallon barrel which was supposed to produce 500 pounds of vinegar.

The time of fermentation varies with conditions and may last as long as 30 days. At the end of the fermentation the vat is transferred to an open courtyard for exposure to the sun. The time for aging is rather indefinite but apparently it lasts for several months. There is no free liquid apparent in the system during the aging period.

After aging, the vinegar is leached from the mash with water--enough water to obtain about 500 pounds of vinegar. It resembled in taste weak American vinegar.

It is claimed that the process for making vinegar is more difficult to control than that for making soy sauce. Apparently, the temperature during the early fermentation period may go too high or the salt may not be added at the right time.

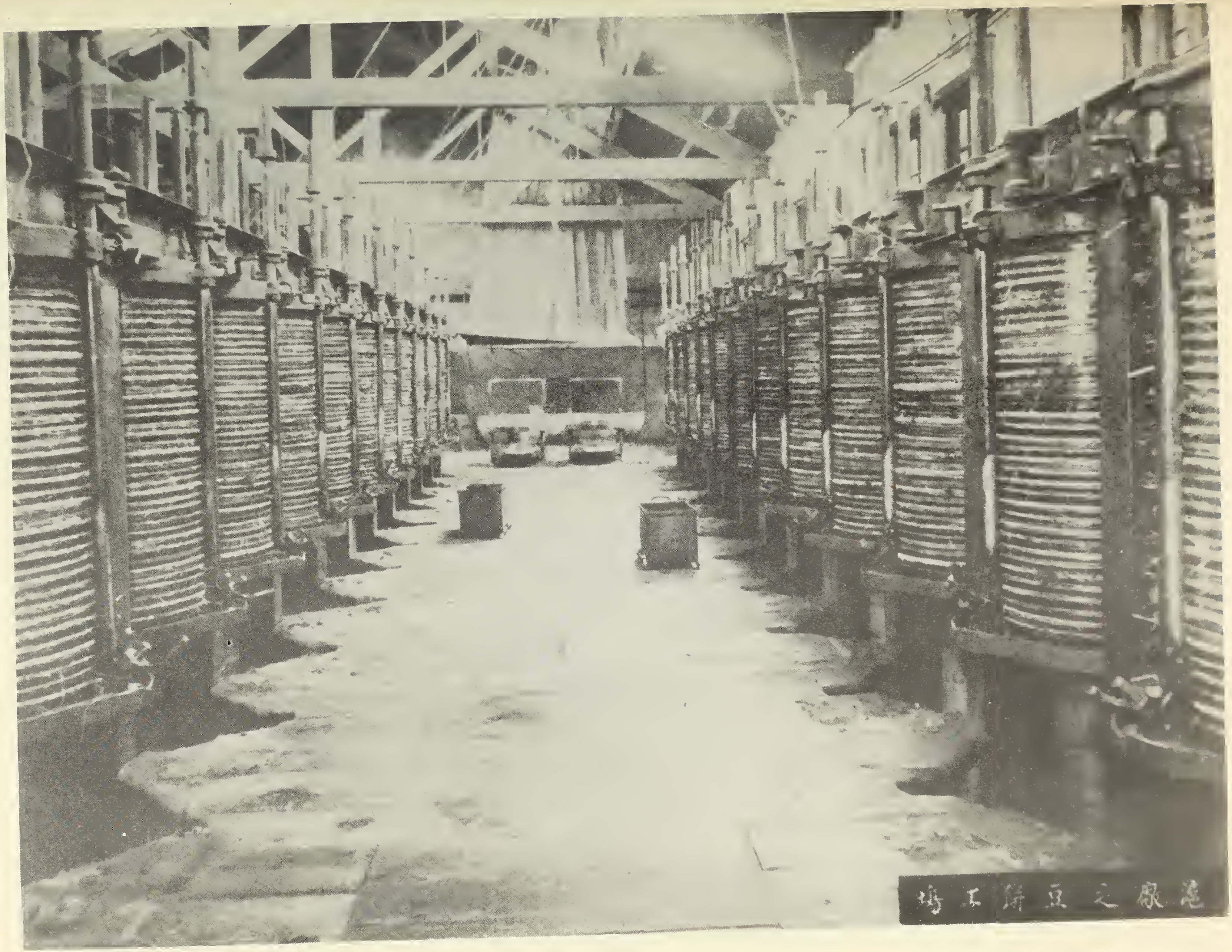


Figure 14.--Hydraulic presses in the mill of the China Vegetable Oil Company, Shanghai, China. June 1948.

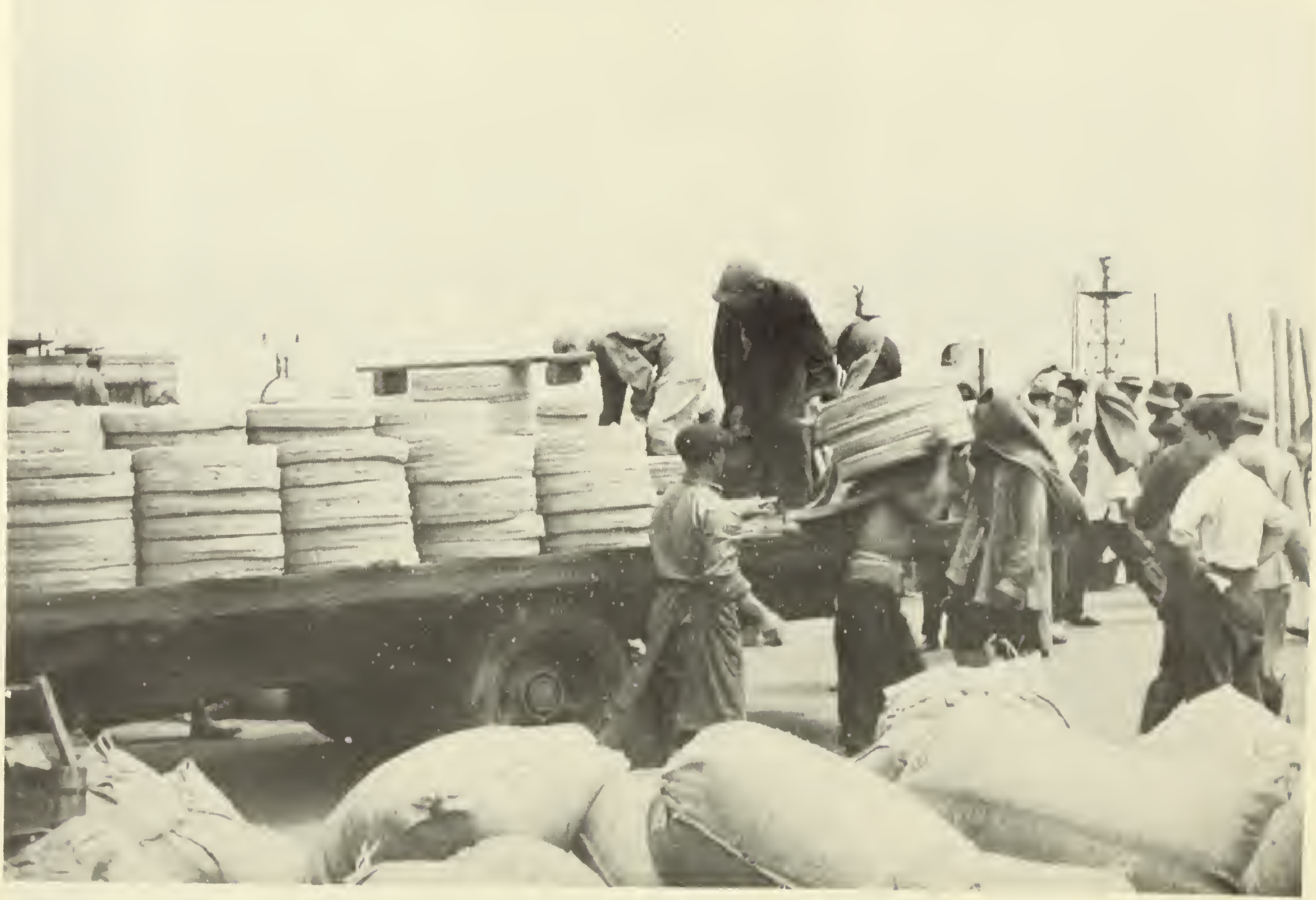


Figure 15.--Loading soybean hydraulic-pressed cake. A scene on the Bund, Shanghai, China. July 1948.

PART II. CHINA -- CHINESE INSTITUTIONS

Henry Lester Institute

A visit was made to Dr. Bernard E. Read, Head of Henry Lester Institute, 1320 Peking Road, West Shanghai. Dr. Read has carried on many years of study on the foods used by the Chinese people. Because of the then current financial situation of his Institute he was able to operate only on limited scale and had rented much of his space to other agencies.

Dr. Read gave me an interesting and valuable bulletin he had published recently, a translation in part from the 15th century "Famine Herbal," first written by Chou Ting-Wang and known in Chinese as Chiu-Huang Pen-ts'ao, a treatise on plants fit for food in time of famine.

Chou lived at Kaifengfu, Honan province, from 1382 to about 1400 and then moved to Yunnan, where he died in 1425. The original edition consisted of two volumes but a later edition of four volumes was compiled by his son, Chou Hsien-Wang, which appeared in 1559. This latter edition is now current.

The "Famine Herbal" is an original compilation based for the most part on Chou's own experience in Kaifeng south of the Yellow river, and in the Mi Hsien and Hui Hsien areas north of the river. The "Herbal" describes 414 plants; 138 of which had been recorded in earlier works on materia medica. Dr. Read's treatise includes the Chinese name of the plants, their botanical identity with authority, the English name with reference to botanical description, the chemical analysis when known, notes on food uses of the plants, and other general information. The translation of the "Famine Herbal" into English required an uncommon knowledge of the Chinese written language, which Dr. Read has acquired during his many years of work in China.

Dr. Read also gave me a copy of his bulletin on Shanghai Foods, fourth edition. This book contains considerable information on composition, nutritional value, and preparation of food in the Shanghai area.

In regard to his work on soybean milk, Dr. Read stated that the addition of a small amount of egg yolk to the milk greatly improved its flavor and nutritional value.

Dr. Read was currently working on the preparation of vitamin C from the haw berry.

Academia Sinica

The Academia Sinica is a national organization for promoting and coordinating research in all branches of organized science and to supervise the operation of other government-supported research institutes. The headquarters are located at Nanking; however, the section visited was at Yo Yang Road, Shanghai. The Academia Sinica at Shanghai has a building which compares favorably in size with the Northern Regional Research Laboratory and was established with the Boxer Indemnity fund returned by Japan. The Shanghai branch serves as a temporary site for the Institutes of physics, chemistry, zoology, botany, psychology, mathematics, medicine, and engineering. As the scientific research program of China develops, the Shanghai Laboratory expects to concentrate more on medical research than on other branches of science.

The head of the Institute's work on plant genetics and plant breeding, Mr. Chung Ying Li, was interviewed. He said that they were doing no breeding work on soybeans at present. The area in which he is interested grows more wheat and rice than soybeans. The soybeans in his area are used largely as a border crop for cereal grains and a large percentage of them are picked green for immediate table use; therefore, the ultimate yield is not regarded as a deciding factor in their cropping system.

Mr. Li was greatly interested in wheat breeding experiments. He was studying the cross breeding of wheat as it affects the length and compactness of the head. He has a theory that an oxidizing agent in the plant, which is regulated by certain genes, affects the amount of auxin and, in turn, controls the formation of the head of wheat. He is trying to prove his theory.

China Vegetable Oil Corporation (CVOC), Hamilton House, Kiangse Road

The China Vegetable Oil Corporation is the largest and most progressive oil processing company in China. Its eminence is probably due to the direct support it receives from the Chinese National Government. Branch offices are maintained in Tientsin, Nanking, Hangchow, Canton, and other cities of China. All officers of the corporation were very generous in assisting me in locating small shops engaged in processing soybean food products and in furnishing interpreters and transportation on many occasions. I wish to mention especially the assistance given by Mr. C. C. Chang, president and general manager, Mr. A. K. Hoo, vice-president, Mr. Tao, and Mr. Yeh.

The CVOC has two oil mill plants in Shanghai; only one was in operation at the time of my visit. This plant had 16 screw presses, about half of them of an old-fashioned German type, the others being Anderson Expellers. The German type had a capacity of only about 10 tons per day, and all of them were so badly worn that they were very inefficient, as indicated by the percentage of oil remaining in the cake.

They had two sets (24 each) of hydraulic presses, with one set in operation. Figure 14 shows one set of hydraulic presses of the CVOC in Shanghai, and figure 15 shows the press cake being loaded for shipment. Figure 8 is one type of the wedge press which is used throughout China and especially in the interior.

The soybean cake as it comes from the hydraulic presses is a flat disc about 5 inches thick and 24 inches in diameter. A crew of about 15 men is required to operate one set of 24 presses.

For processing in the hydraulic presses, the beans are first converted to coarse flake, then treated with live steam. The steam treatment is carried out by placing an amount of flakes sufficient for a single cake on gunny sack material stretched over a live steam exhaust. Two loose bundles of straw which are used later to hold the flakes in the preform mold are laid loosely over the flakes during the approximate 1 1/2 minute of steaming. The straw is then placed inside two steel rings in which the cake is to be preformed, the flakes added, a cloth pad placed over the hot damp flakes and tamped vigorously with the feet. The pad is removed, the ends of the straw folded over the top of the flakes and the loosely formed cake placed in a low pressure mold which further presses the flakes into a cake that holds together while being transferred to the hydraulic press. The cake is held in the press about 30-45 minutes.

When the cake is removed from the press, the edge of the cake, which contains considerable oil and some adhering straw, is shaved with a draw knife and the shavings returned to the press. The soybean cake is very hard, but farmers prefer to purchase their soybean meal in this form, as it assures them that it is unadulterated.

The mills operate two shifts per 24 hours. Each shift works 7 days one week and 6 days the next. The workers' holiday, once every 2 weeks, is called Big Sunday.

During the filling of the presses, the men work very rapidly but they have a rest period while the presses are operating. The few clothes the men wear consist of a burlap cloth around the knees for protection and a short burlap skirt or loin cloth.

The oil for domestic consumption in China is unrefined. Following the pressing, it is heat treated in large tanks containing steam coils and then filtered. This raw, dark-colored oil is retailed in small shops for home use. When the oil is prepared for export it is neutralized, centrifuged, water washed, and centrifuged again. The CVOC plant at Shanghai was the only oil plant visited that had facilities for operating a refining process.

The CVOC also processes vegetable tallow, rapeseed, cottonseed, sesame, peanuts, tea seed and other oilseeds.

The tallow tree (Stillingia sebifera) produces a nut about a half inch in diameter which bursts open when ripe, exposing three seeds. The seeds consist of an oily, proteinaceous kernel, enclosed in a hard, black shell thickly covered with a layer of firm, white fatty substance which consists of vegetable tallow, about 20 to 30 percent by weight. After removal of the tallow, the seeds are cracked and pressed to obtain the oil, which is known as Stillingia oil.

The tallow is used for candles, lubricants, soap, hair pomade, and treatment of sores and skin diseases. Stillingia oil has an iodine number of 180-187 and is used as a drying oil. The bark of the tree is used in medicaments.

The tallow tree is native to central and eastern China, especially in the provinces of Chekiang, Kiangsi, and Hupeh. It has aspen-like leaves which turn to a brilliant red in autumn and winter.

Rapeseed oil, when the supply of materials is low, is processed by passing it through the screw presses twice. Most of these oils, especially for export, are shipped in used steel drums. Used drums, rather than new ones, are preferred in order to avoid the tax imposed when new ones are purchased.

The CVOC has plans for the purchase and operation of a solvent extraction plant of about 150 tons' capacity. The corporation is waiting for a more suitable money exchange rate before purchasing the equipment.

The China Oils and Fat Industries Ltd.

This company is in the process of installing, under the supervision of Mr. H. P. Fan, 50 Hankow Road, two screw presses at Shanghai. Mr. Fan is also consulting engineer for Shingku Trading Co., Ltd., Shanghai. This latter company is in the process of purchasing and installing batch-type solvent extraction equipment for oilseeds.

The extraction equipment is from the Societé Anonyme Edoward Batille of Paris. The plant will be erected in Szechuan province about 1,000 miles west of Shanghai. They expect to use hexane as a solvent.

National Bureau of Industrial Research

This organization occupies two buildings for chemical research, one at 352 Cheng-Ning Road and the other at 1317 Szechuan Road, North. They have another set of buildings which are used as a pilot plant for soy sauce production, and a fourth building for mechanical and engineering research. The headquarters for their laboratories are in Nanking, P.O. Box 108. Dr. Yu-Tsuan Ku is the Director. They have a northern branch at Peiping, a northwest branch at Lanchow, a southeast branch at Chunking and another branch on Formosa. These laboratories are concerned with any type of chemical work ranging from the setting up of control analysis for industrial companies to the development of new products and processes. They have divisions to cover the following subjects: fermentation, analytical chemistry, oils and fats, textiles, pure chemistry, ceramics, leather, plastics, sugar, cellulose, and electrical and mechanical and other subjects. Examples of some of their projects are:

1. Selection of proper clay and development of a process for making alum. At present there appears to be no alum production in China.
2. Study of pottery clay and development of methods for making pottery.
3. Extraction of vegetable tanning materials and a study of the tanning process.
4. Analysis of the various minerals of China.
5. Analysis of water and its variation with the seasons.
6. Plywood glues and plywood manufacture.

7. Study of plastics, synthetic and natural.
8. Isolation of the effective organisms for preparation of soy sauce.
9. Laboratory and pilot-plant studies on making soy sauce, especially on these factors responsible for the flavor and aroma of the sauce.

Some problems on the production of soy sauce in which they are particularly interested are:

1. How to improve the flavor of soy sauce manufactured by the quick process.

    (a) During fermentation - the effect of irradiation with ultraviolet light; the addition of catalysts to promote hydrolysis; selection of more effective organisms and better conditions for their activity.
    (b) The addition of synthetic flavor to the sterilized sauce.

2. What effect the sun's rays have on the enzymes and molds during fermentation.

3. How water instead of brine can be used during the fermentation.

4. How soy sauce can be preserved during the summer.

5. How fish meal can be used in sauce manufacture.

Catholic University (Fu Jen)

Harold W. Rigney, S.V.D., Rector (recently from Chicago University); Rev. George B. Mathews, Ph.D., S.V.D., Head, Department of Agriculture; Mr. Chang Chung Yi, Secretary General and Professor of Economics; Professor W. Brull, Head, Department of Chemistry.

Catholic University at Peiping receives about 60 percent of its support from the people of the United States; however, all students are required to make some small payment toward their tuition and supplies. The University has many fine buildings and a fair amount of equipment and supplies. About 2,500 students are enrolled at Fu Jen. In addition, the University trains priests for missionary work in other parts of China. Peiping is recognized as the most important educational center of China, and the language spoken in the Peiping area is given recognition as the most desirable of the many Chinese dialects.

The University is reasonably self-contained in that it has a Diesel engine for generating its own electricity when the city system fails (which is quite often), a "home made" water-gas generating plant using a special coal found near Peiping, a machine shop, a metal-working shop and a printing shop with three linotype machines.

Catholic University is currently organizing an agricultural department under the direction of Rev. George B. Mathews. The chemistry department under Professor W. Brull is well organized and has a large enrollment. Mr. Frank Liebenthal, a displaced person from Germany, was quite active in the fermentation division. He furnished a group of seven samples of microorganisms for transfer to the Northern Regional Research Laboratory and also assisted in locating industrial fermentation processes and acted in part as an interpreter.

Yen Ching University, Peiping

Yen Ching is a Christian University with one of the highest scholastic ratings in China. Dr. Leighton Stewart was president of this University for many years and now is Ambassador to China.

Dr. William H. Adolph, who followed Dr. Stewart as acting president of the University, planned, at the close of the 1947-48 school year, to transfer to the Pekin Union Medical School so that he could continue his work on nutrition.

Dr. Adolph is one of the foremost authorities on nutrition in China. In discussing the use of the soybean in China, he stated that the Chinese people do not use the whole soybean to any great extent as food. Many of the Chinese people find the whole bean difficult to digest and it is probably for this reason that fermented soybeans or the various forms of soybean curd are the preferred products. Additional information on the peasants' diet, obtained from Dr. Adolph, was reported in the section on farming conditions.

Agriculture Experiment Station, Peiping

This Station is a part of the National Agriculture Bureau with Dr. Song-en Tai as Director, Dr. C. F. Loh, Biochemist, and Dr. K. T. Chen (former visitor of the Northern Regional Laboratory). The Station was built in 1938 by the Japanese during their occupation of China. It consists of 15 buildings of brick and stone construction, 400 acres of land, and a staff of 272 persons.

It was being operated by the Chinese, who had grouped the work into 8 divisions: (1) wheat, (2) cotton, (3) horticulture, (4) soils and fertilizer, (5) plant pathology, (6) agricultural engineering, (7) entomology and (8) miscellaneous. It also had four branch stations and two seed farms, although some of these stations were currently in the hands of the Communists. The Station's program included breeding work on wheat, millet, kaoliang, corn, soybeans, cotton, hemp, and tobacco. It was seeking new varieties of these crops that would be resistant to disease, drought and cold, and with a tolerance to a soil having a high salt content. The program also included work on fruits such as pears, apples, grapes, and peaches, and on sugar beets, white and sweetpotatoes, and common leafy vegetables. Large areas of land in North China have become unproductive because of the accumulation of salts in the soil. This

Station is trying to reclaim this land by selection of salt-tolerant varieties, by the removal of salts, by the use of minimum amounts of fresh water for irrigation, and the prevention of the rise of alkali by lowering the present underground water level.

Irrigation methods to supplement the rainfall of North China were also being investigated since the distribution of rainfall during the year is not suited to the best growth of most crops.

Their breeding work on soybeans was started in 1948 with varieties of soybeans gathered from a wide territory in order to select the best variety for the Peiping area. Samples of the following varieties of soybeans were given me by the experiment station for trial in the United States.

Collection number	Variety
31	Changteh--tiger skin bean
32	Paoting--black bean from Paoting and Hopeh
33	Split yellow beans of August
34	Chi Wa--white sea bean
35	Peiping--tiger skin bean
36	Peiping soybean--local name Peiping large yellow bean
37	Soybean from Ma Chiu Chiao--a town 10 miles from Peiping
38	An Yang--black bean from An Yang, Honan province
39	Anyang green bean--from Anyang of Honan province
40	Green bean from Ma Chiu Chiao--a town 10 miles from Peiping

Other soybean samples, Nos. 41, 42, and 42A were purchased at the grain market at Peiping and are of unknown variety.

In North China the land is utilized about 140 percent by double cropping 40 percent of it each year. For example, wheat or barley planted in September or October is harvested in June. This land may then be planted to soybeans, corn, sweetpotatoes, cotton, tobacco, or other summer crops. The following spring kaoliang or millet will be planted and harvested in September, and the cycle restarted by following with wheat or barley.

Shantung province is the heaviest soybean producing area in China and soybeans are grown there as the principal crop. This province is credited with 70 percent of China's soybean production, Honan province with 20 percent, with Shansi province next in order. This production rating probably refers to commercial seed production; an estimation of production for home food use would be difficult to make.

PART III. JAPAN

Agriculture always has been the leading industry in Japan. It provided employment for more than 40 percent of the population before World War II and supplied about 85 percent of the nation's food. The remainder of the Japanese food requirements was made up largely with soybeans from Manchuria, rice from Korea, and sugar from Formosa. The loss of her colonies and the destruction of many of her home industries as a result of the war has intensified the importance of agriculture to Japan.

To help visualize the Japanese situation, we might turn to the report of the National Resources Section (NRS) of the Supreme Command for the Allied Powers (SCAP). In a section dealing with the "Outlook for Japanese Agriculture" it is stated that "approximately 80 million persons will have to maintain themselves in 1950 on a comparatively small land area, about equal in size to Montana, that is basically poor in natural resources." In fact, only 16 percent (about 15 million acres) of the land area of the Japanese islands is arable. Prior to the war the Japanese people were living on a daily intake of about 2,150 calories. Immediately after the war their food production dropped to provide a ration of probably less than 1,600 calories per person; however, with outside help it was currently estimated at about 1,850 calories. To appreciate fully the position of Japan, the report points out that further increases in Japanese crop production will be small, and it is indirectly indicated that the increase in population and corresponding food requirements will grow more rapidly than her agricultural production. Under such conditions, Japan must develop industries and foreign trade in order to obtain her food requirements.

The Japanese are very aggressive in their agricultural research program; in fact, Japan's zeal for agronomic research, as reported by SCAP, has led to the establishment of more than 600 experiment stations. Many of these stations were small, and under the present guidance of SCAP officials it was expected that the number would be reduced through consolidation of experiment station work. Work on one of their agricultural experiment stations is shown in figure 16.

Prior to the war, agronomic work on soybeans was given less attention than that on other crops such as rice, wheat, and sweetpotatoes. This de-emphasis on soybean breeding work was due to Japan's access to Manchuria as a source of soybeans and where the soybean breeding program was concentrated. Yearly importations were in excess of more than 900,000 metric tons (33 million bushels). Home production of soybeans before the war was 300,000 to 350,000 metric tons (11 to 12.8 million bushels). Present production is about 280,000 metric tons, an amount the Japanese hope to increase to near prewar quantities. Average yields per acre have also dropped in recent years, probably due to shifting soybean culture to less fertile land areas.

The current difficulty of increasing production was the unfavorable price ratio of soybeans to that of rice and sweetpotatoes per unit area of farm land.

That high yields of soybeans are possible in Japan is illustrated by results in a yield contest sponsored by the government. The prize-winning yield was 4.2 koku per tan. (1 koku = 5 bushels and 1 tan = 1/4 acre.) This is a yield of 88 bushels per acre. Other contestants produced 3.9, 3.8, 3.7 koku per tan. The winner of the contest grew his beans in a so-called mountainous region; however, it was the opinion of the official reporting the data that the area was not very high above sea level, perhaps 300 meters, as a guess. The average yield of soybeans in Japan in one report is given as .881 metric tons per acre while in another report as 0.71 koku per tan. The lack of complete agreement is shown in that the first report cites 12.9 bushels and the second 14 bushels per acre.

While soybeans are grown throughout Japan, Hokkaido is the largest soybean producing area. Here the beans are planted in May and harvested in September. Soybeans that are taken from Hokkaido to southern localities usually mature much earlier than in their native habitat, especially during the first year. In the second year a variety will extend its growing season 7 to 10 days beyond that of the first year. While many of the northern varieties cannot be successfully grown farther south, some selected varieties have proved unusually successful.

The Japanese make a general classification of their soybean varieties into early, medium, and late maturing types. The early and very late maturing varieties have the advantage of avoiding the insect damage to which the others are subject. The early maturing varieties are used almost entirely as food, with many of them classed among the so-called vegetable types.

To obtain soybeans very early in the season, planting is done in beds and the seedlings transplanted early in April. The crop is harvested in late June or early July. In some localities even the transplanting of field varieties has attained some popularity. The practice of transplanting soybean seedlings has been copied probably after the custom of transplanting rice. This practice saves about 3 weeks of the time the crop occupies the field and has made possible the practice of double cropping in areas farther north. It is Japanese experience that soybeans grown in a normal manner on very rich soil do not yield well, although if the seedlings are transplanted on rich soil they will make an excellent yield.

Other oilseed crops of Japan are sesame, peanuts, rape, castor beans, and flax. In wartime, the Japanese grew some sunflower. A small quantity of oil from the Abura Kire or oil tree is processed also. This is the same as the tallow tree of China and gives the same products.

Production of Miso in Japan

The miso of Japan is the same as the soy paste of China; however, the relative importance of the product in the two countries is not the same. In China soy paste production is small in comparison with the production of soy sauce, whereas in Japan the miso is of greater importance than the sauce. Miso is used so extensively in parts of Japan that its caloric value is included in the food rationing program established by the Supreme Command for the Allied Powers. In some localities it furnishes 25 percent of the protein requirements. Miso has a flavor like soy sauce; it is made similarly to soy sauce except that less water is used in fermentation and the entire product, rather than the filtered liquid, is eaten.

Miso production starts with two parts of soybeans and one part of wheat, rice, or other starchy grain. The finished product analyzes 15 percent protein and about 12 percent salt on a 50-percent moisture basis. However, some producers are attempting to reduce the salt content to as low as 6 percent. A miso plant, partly destroyed by bombing during the war, and some of the wooden tubs used in the fermentation process are shown in figure 17.

The largest single use for miso in Japan is in soup--many Japanese eat soup three times a day. Miso is also a spread for bread in the same way Americans use butter, and on cucumbers or other raw vegetables for adding flavor. Along with sugar and oil it is used in cooking fish, meat, and vegetables. Although manufacturers seldom add condiments to miso, it is a common practice for the housewife or cook to add condiments at the kitchen stage of food preparation.

The Japanese produce three kinds of miso which are known as white, red, and black. Different starting materials are used for each of the three. White miso, the sweetest variety, made with soybeans and rice, contains less salt than the other two types. It also is made with more koji than is the red miso. The time required for making white miso will vary from a week to a month. It is consumed mainly around Kyoto, Kobe, and Tokyo.

Red miso is made with soybeans combined with either rice, wheat, or barley, but it contains more salt and a larger ratio of soybean to starchy material than does the white miso. Red miso is consumed throughout the islands of Japan. In addition to the uses mentioned above, red miso is used in preserving vegetables such as egg plant, burdock root, and melons.

Black miso is made entirely from soybeans. In flavor it resembles soy sauce. Producers claim that it requires 1 to 3 years to make the good and best grades of black miso; however, due to the shortage of food since the war, it is now being turned out within 2 to 3 months. One of the special uses for black miso is for making a special type of oyster soup. Black miso is made and consumed mainly in the prefecture of Nagoya.

As indicated, the whole soybean is normally used in making miso, but since Japan was short of soybeans she was of necessity using soybean cake and soy flour imported from the United States.

While the Oriental countries use soybeans extensively in various forms as food, they are not familiar with American type soy flour and shipments of soy flour to Japan created new problems for them. The difficulty was further aggravated by poor storage conditions which degraded the flour and made it still less acceptable to the people. The better storage space was used for rice, because of its greater importance. The miso producers, under pressure from the SCAP officials, were finally induced to try it in their product. The early results indicated that use of soy flour in miso production gave satisfactory results. In fact, the only evident problem in using soy flour was that of increasing its moisture content sufficiently for the steaming operation.

In miso production the soybeans, soy cake, or soy flour is steamed before mixing with the cereal grain. The soy flour tends to form lumps on the addition of water and results in uneven moisture distribution. The koji (fermenting organisms, the principal one being Aspergillus oryzae) for miso is prepared on steamed rice or barley, the whole kernel being used. Koji preparation is carried out in a special room in the basement of the plant; the heat from the fermentation reaction keeps the room warm and the basement location helps to maintain a high humidity.

In the fermentation process the soybeans, soy flour, or cake is mixed with the mold organism in a rectangular box by hand shoveling and the mixture is allowed to stand in the box overnight. It is then placed on small wooden trays along the walls of the fermenting room for about 24 hours. At the end of this period the fermentation has proceeded far enough. To this mixture an equal amount of fresh raw materials is added, and after the addition of salt it is placed in large, wooden vats (approximately 5,000 gallons) for further fermentation and enzyme action. The vats are covered with heavy mats and the reaction allowed to proceed for about 3 months. The rate of fermentation of the various raw materials was reported to be the same.

Because of the shortage of soybeans in Japan, miso was being extended with an equal quantity of sweetpotatoes. Sweetpotatoes used for this purpose are cooked and pickled in salt and mixed with the miso just prior to packing it in wooden tubs for shipment.

Soy Sauce in Japan

The importance of soy sauce to Japan is well illustrated by the Noda Mati plant of the Kikkoman Shoyu Company, Ltd., which was founded in 1764. This is the largest soy sauce plant in Japan and probably the largest in the world for making a fermented type soy sauce.

The annual production of shoyu at Noda has been as much as 23 million gallons, consuming 30,000 metric tons (11 million bushels) of soybeans, 27,000 metric tons of wheat, and 29,000 metric tons of salt. The Noda city factory includes 8 brewing plants, 1 bottling plant, 1 barreling plant, 6 auxiliary plants for construction of barrels and other materials used in their process, and a research laboratory with a staff of more than 30 workers. The factories of the Noda city plant are spread over 2,333 acres of land. It is claimed that the general occurrence, throughout the small city, of the mold used in fermenting shoyu suppresses other bacterial life and maintains a high health standard for the city.

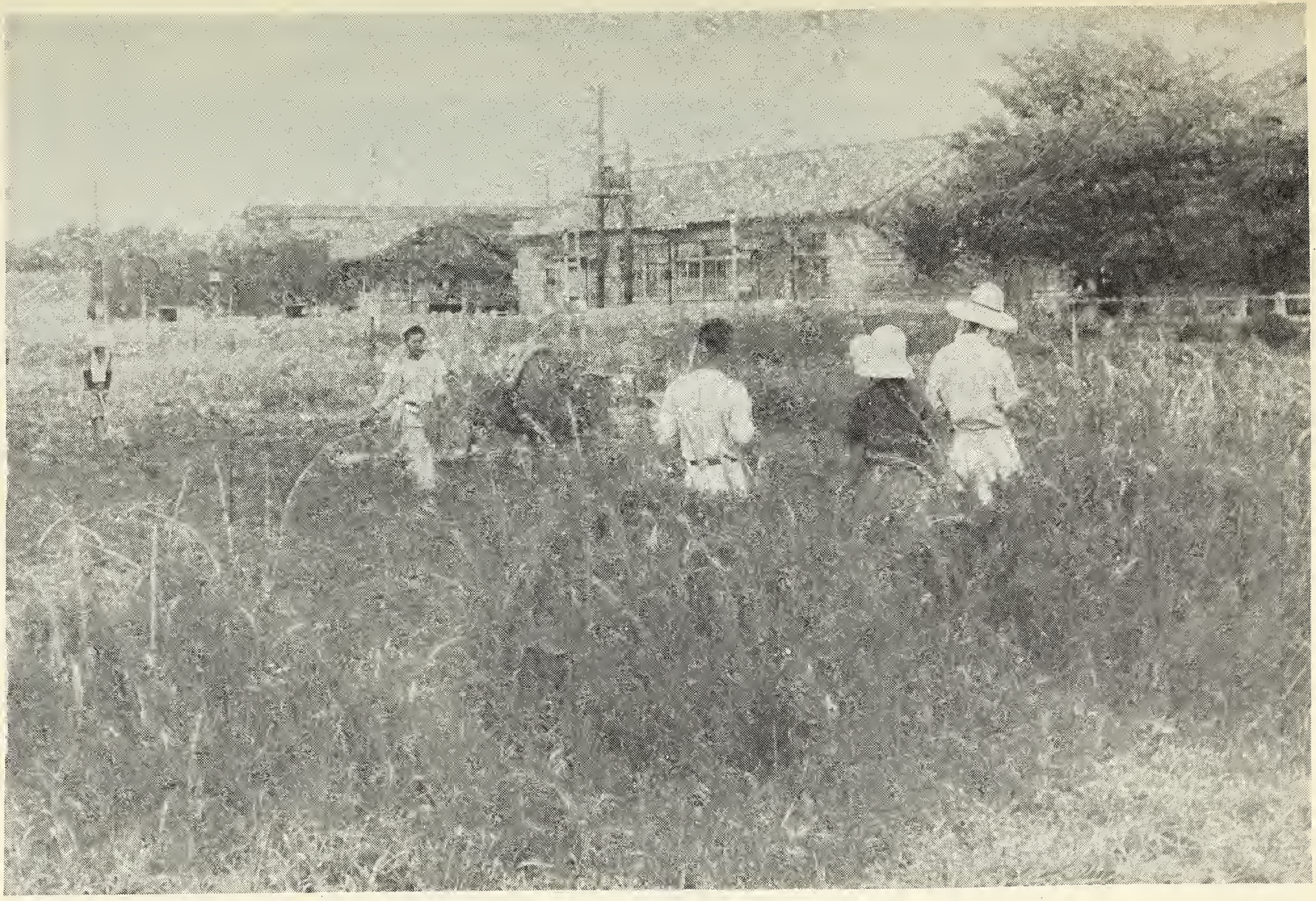


Figure 16.--Preparing a seed bed at a Japanese agricultural experiment station near Tokyo. 1948.

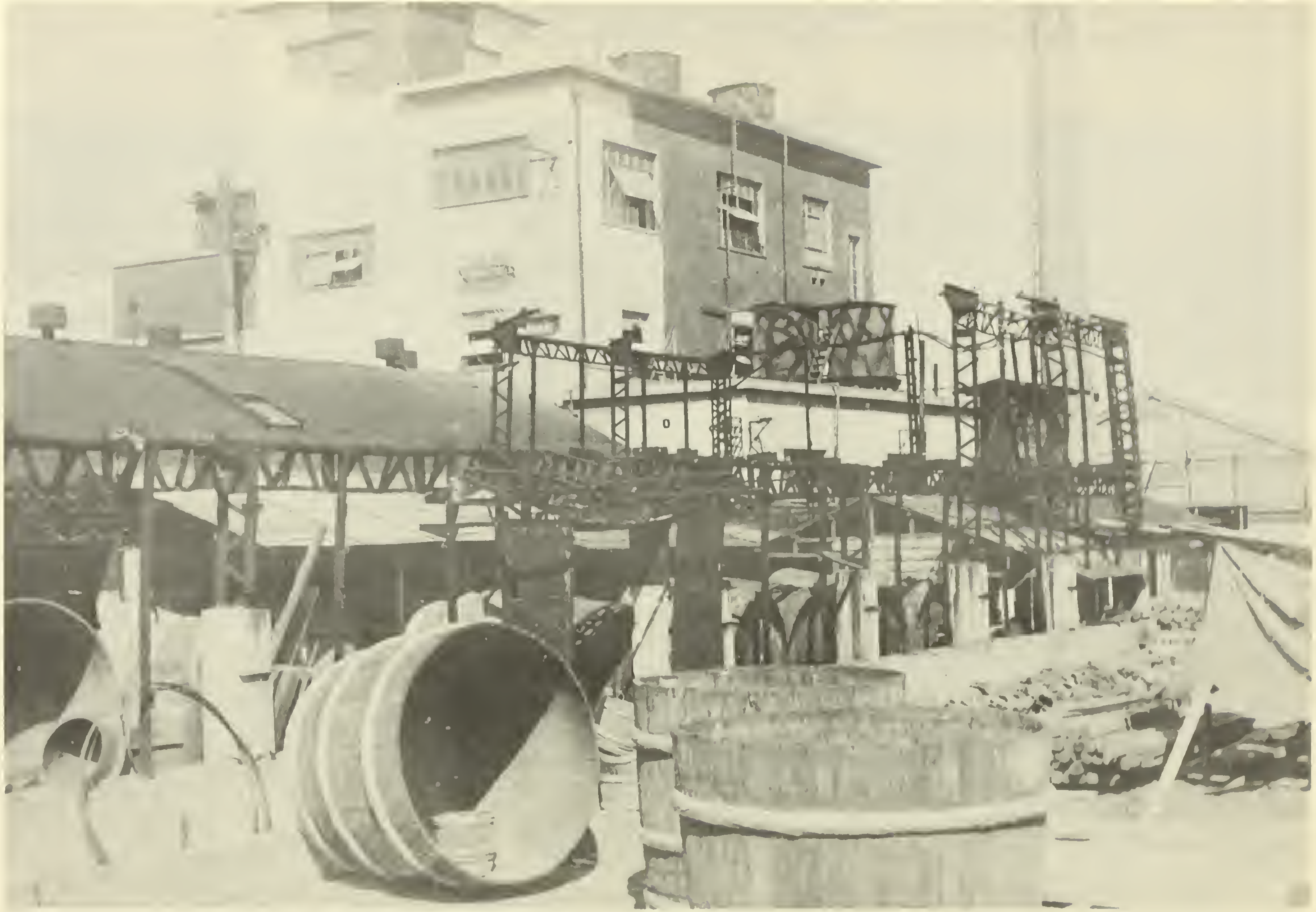


Figure 17.--A miso plant in Tokyo. The large tubs in foreground are used for the fermentation of miso. A part of this plant was destroyed by bombs during the war. August 1948.

The preferred raw material at this plant for making shoyu are soybeans and wheat, although at the time of my visit soybean meal from the United States was being used. In their process (see attached flow sheet) the soybeans or soybean meal is steamed in large steel-jacketed vessels for about 12 hours. In the steaming process, the pressure is brought up slowly to 10 pounds per square inch where it is held for about an hour, then is allowed to drop very slowly to zero.

The steamed soybeans then are dumped on a cement floor and mixed with wheat which has been parched and cracked. This mixture is then inoculated with specially selected types of Aspergillus oryzae and placed in wooden trays about 14 by 24 inches in area and 4 inches deep. The trays are stacked in large fermentation rooms (12 by 50 feet) for about 72 hours. The heat of fermentation warms the material to 40° C. and it is held at approximately this temperature. The molded material is now mixed with salt water and placed in cement tanks for further action by microorganisms. This plant has 1,500 cement fermenting tanks, each holding 100 koku (1 koku = 47.65 gallons). During the summer and when fresh material is added, the tanks are stirred about 10 times per month, and in the winter less often. The stirring is performed by bubbling air into the bottom of the tanks. For a good grade of soy sauce the mash is fermented 8 to 12 months. Owing to the current pressing need for the sauce, the fermenting period often has been shortened to 3 months.

The composition of high-grade shoyu from the Noda city plant was given as follows:

	Grams in each 100 ml.
Total solids	38.13
Total nitrogen	1.51
Albuminous nitrogen	0.09
Non-albuminous nitrogen	1.42
Amino nitrogen	0.70
Volatile acids (as acetic acid)	.14
Non-volatile acids (as lactic)	.65
Sugar (as glucose)	5.99
Dextrin	1.06
Mineral matter	19.70
Sodium chloride	18.02
Phosphoric acid (as P_2O_5)	0.48
Viscosity (Ostwald at 25° C.)	4.84
Hydrogen ion concentration - pH	4.6
Specific gravity at 15° C.	1.2000

Owing to the shortage of raw materials, the standards for soy sauce have been reduced to about half of the above composition, except that the same salt concentration has been maintained.

Monosodium Glutamate

When Dr. K. Ikeda of Tokyo Imperial University was attempting, prior to 1908, to isolate from shoyu the constituents responsible for its good flavor, he discovered glutamic acid or its salt, monosodium glutamate (MSG), to be the principal flavoring constituent of soy sauce. Dr. Ikeda then devised a method for isolating glutamic acid from soybean hydrolyzates and in 1908 obtained a Japanese patent on the process.

A pilot plant was built immediately for the making of MSG at Zushi, 20 miles southwest of Tokyo by S. Suzki, a friend of Dr. Ikeda. The pilot-plant development was successful, and in 1914 a full-scale plant was built at Kawasaki, 8 miles south of Tokyo.

The trade name given their products was Aji-no-moto, meaning "essence of taste" and the company is known as the Ajinomoto Co., Inc. The production of ajinomoto increased steadily to 40 tons per month until the earthquake of September 1923 entirely destroyed the plant. The plant was immediately rebuilt and had attained a capacity of 50 tons per month by March 1924. Yearly production was further increased as follows:

Year	Tons
1929	1,000
1934	2,000
1935	2,300
1939	3,000

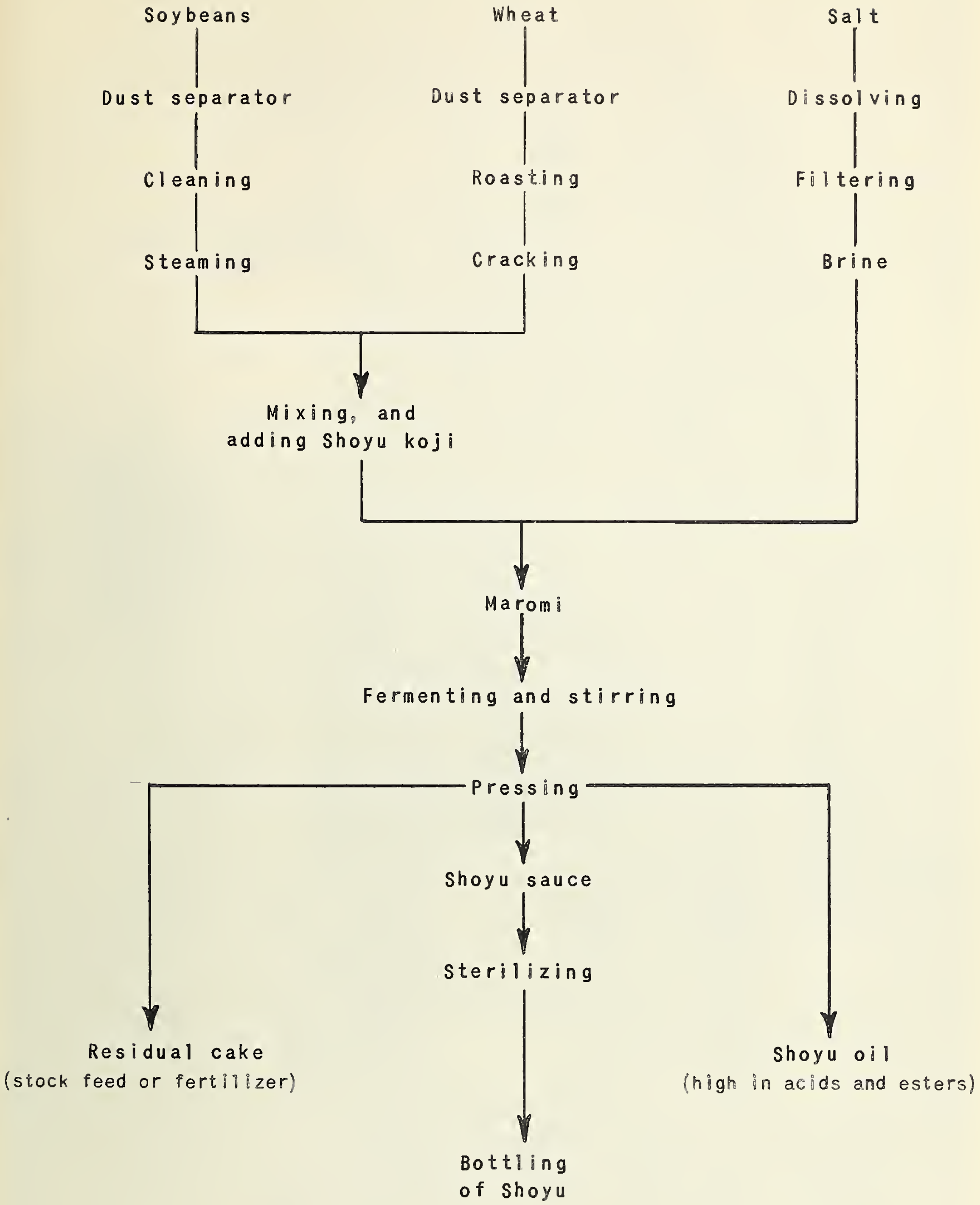
The maximum production of 3,750 tons was reached in 1937. After 1939, production decreased because of the war. During the war 38 percent of the plant was destroyed by bombing. Figure 18 shows presses formerly used for filtering monosodium glutamate but now inactive as a result of bombs.

Since the war, the Ajinomoto Co., Inc. has recovered production to about 20 tons per month. There are about 30 plants in Japan producing MGS but they are all very small except that of the Ajinomoto Co., which manufactures about 90 percent of the total Japanese production. Figure 19 shows tubs of ajinomoto ready for shipment.

The plant was operating in 1948 on solvent-extracted soybean meal from the United States, although wheat gluten, if available, would have been the preferred raw material. The first step in their process consists of extracting the meal at the isoelectric point of the protein (about pH 4.2). This removes soluble sugars and soluble nitrogen compounds, and thus raises the nitrogen content of the meal to about 10 percent. The meal is hydrolyzed with 17 percent hydrochloric acid at 30 pounds per square inch steam pressure for 15 to 18 hours.

It was not possible to get a clear picture of their entire process because the company's equipment was widely scattered. According to their description, ajinomoto and chemical soy sauce is manufactured from the

OUTLINE OF BREWING PROCESS FOR SHOYU



Flow diagram for the production of Shoyu (soy sauce) at the Noda Mati plant at Noda City, near Tokyo, Japan.

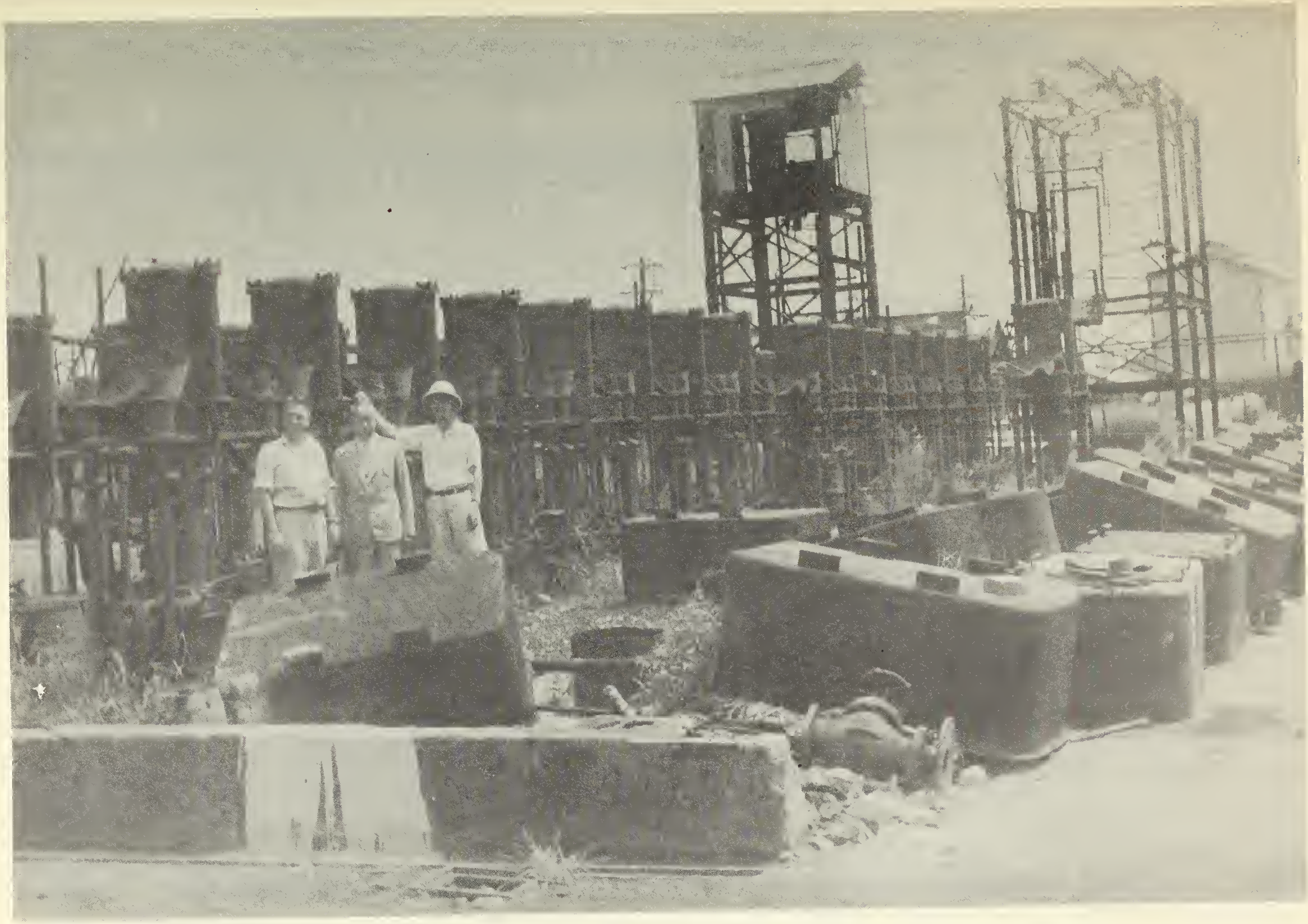


Figure 18.--Presses destroyed during bombing raids over Tokyo. These presses formerly were used for filtering monosodium glutamate. July 1948.

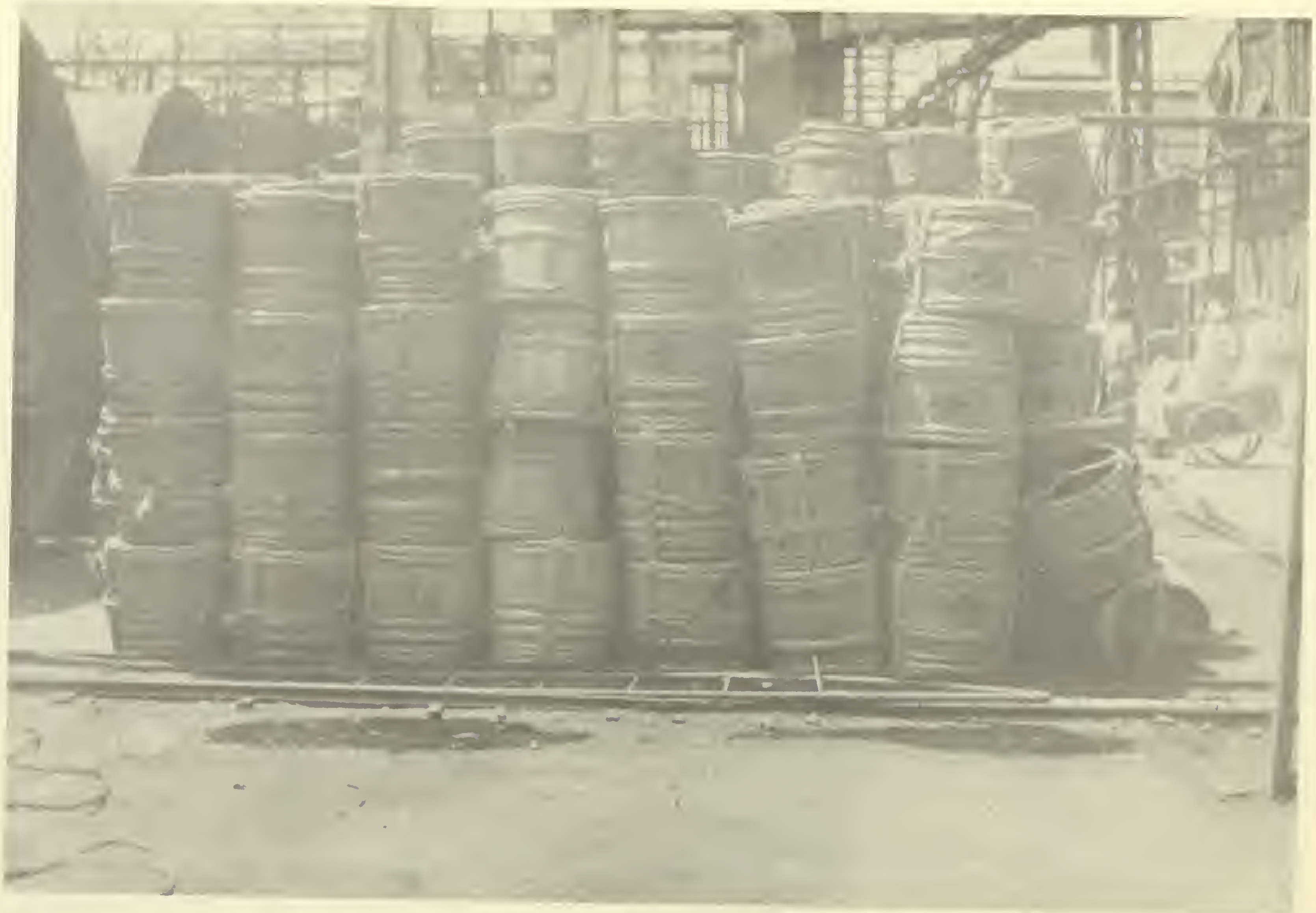


Figure 19.--Tubs of ajinomoto (monosodium glutamate) ready for shipment, at a plant located between Tokyo and Yokohama, Japan. This plant had a maximum production of 7.5 million pounds of ajinomoto in 1937. August 1948.

same raw materials. After the acid hydrolysis, the hydrolyzate is partly neutralized and a crop of glutamic acid crystals is removed. The remainder of the hydrolyzate is used in making chemical soy sauce.

Trends in Soy Sauce Production

Quality in soy sauce is determined by its taste and aroma. Oriental people are universally agreed that the longer the brewing period in making soy sauce, the more pleasing the product. The early part of the brewing period develops the desired taste, the aging develops the agreeable aroma.

Shortage of supplies and economic pressure is gradually inducing a change in the traditional methods of producing soy sauce in favor of shorter procedures. Producers frequently stated that 2 to 3 years is required for making the best grade of soy sauce. It is evident, however, that in recent years they have seldom aged their product more than 8 to 9 months and much of it is now produced in 3 months.

Chinese producers cling more tenaciously than do Japanese to the traditional method of aging their sauce. For example, the Chinese process still is carried out in 50-gallon earthenware crocks out in the open. Many Chinese insist that sunshine and even the moon are factors in developing good flavor. The only semi-modern plants in China were built by the Japanese during their occupation. One of these plants is at Peiping and another at Tientsen; both are operated by the respective municipal governments.

Chinese scientists are conscious of their problem and the pressing need for more efficient methods of shoyu production. The government is now supporting research on soy sauce at their National Bureau of Industrial Research Laboratory at 352 Chang-Ming Road under the direction of Dr. Pei-Sung King. Another branch of the same organization is at 1313 Szehun Road, N. Shanghai, where Dr. C. T. Siao directs the operation of a soy sauce pilot plant. They hope to reduce the production time without loss in flavor.

The fermentation procedures of the Chinese and Japanese are essentially the same, but the Japanese conduct their operations under cover of a building and have developed more modern equipment for handling their materials.

The newer methods which are competing for favor in Japan are (1) the chemical method, and (2) the mixed chemical and fermentation process. The first method is sponsored by the manufacturers of monosodium glutamate (MSG) because they can use much of their residues from MSG manufacture for their chemical soy sauce. The strictly chemical type sauce is lower in quality than that produced by older methods, but it represents a great saving in production costs, and the quality is still quite acceptable. The older school of brewers cling to the hope they can retain all the traditional flavor and aroma. They are sponsoring a process (No. 2) in which the protein is partly hydrolyzed with acid, this being followed by neutralization, and then fermentation for a period of about 30 days. It is quite possible that both methods will be used and that different standards of quality will be established.

It was said that a few plants were making a soy sauce product from miso. In Japan this kind of sauce is called Tamari.

PART IV. KOREA

Raymond E. Culbertson[2] and Allan K. Smith

Soybeans have been grown in Korea for many centuries. One can speak in terms of centuries; Korea's calendar year is now 4281 in contrast to our 1948. Reportedly, soybeans were brought to Korea from China 2000 to 3000 years ago in the customary exchange of gifts between the ruling houses. Furthermore, according to the records of the Pakja Dynasty with its capital at Puyo, the ruler Chung Chong Namdo, compelled the people to harvest and store soybeans for both food and seed.

Since the high density of population in Korea limits livestock production, it is only natural that soybeans should be grown and utilized in supplying much of the protein needed in the diet of the people.

At the time of my visit, Korea was divided into two zones separated by the 38th parallel. From the area occupied by the Russian forces in the north, no recent information on soybeans was available. South Korea, however, was a republic with the United States occupation forces and advisers still present.

Korea has the village system of farming. Farmers live in small villages, with their lands within walking distance of their homes. The village system, together with isolation caused by mountains and streams, makes transportation and exchange of products difficult. This has contributed to the selection and development of many varieties of soybeans of considerable merit. These varieties for the most part are relatively pure and of many colors and sizes; green, red, brown, black, purple, yellow, cream, and gray, all of which may be found at the same time in one market place in Seoul, the principal market in Korea.

Production figures for South Korea show that, over the years, 8 to 10 percent of the land is planted to soybeans and the yields range from 8 to 14 bushels per acre. These yields appear low but are explained by Korean farming practices. It is the custom to seed small grain in rows in the fall of the year with sufficient space between the rows to permit interplanting with soybeans in May or early June before the grain is harvested.

Prior to World War II, North Korea planted (1940-44 averages) slightly more than 905,000 acres of soybeans annually which yielded some 7,700,000 bushels. During the same 5-year period South Korea planted 626,000 acres which yielded a little over 5,000,000 bushels. The latest available figures (1947) for South Korea showed a production of 4,480,000 bushels from 662,000 acres.

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Breeding Work

During the Japanese control of Korea, the centers for breeding work were in North Korea. The Japanese built about 15 agricultural experiment stations throughout Korea. Figure 20 shows the main building of an agricultural experiment station near Seoul. The present status of the activities north of the 38th parallel is not known. As far as can be ascertained, no plant breeding work with soybeans is now being done in South Korea. However, variety testing and selection of good strains is being carried on at several experiment stations at both the provincial and national level.

The leading varieties in South Korea have resulted from rigorous selection, mainly by farmers, over a long period.

Soybean Varieties

There are many varieties of soybeans in Korea but little attention was given to outstanding characteristics or the naming of varieties prior to the early 1920's when an improvement campaign was begun. In South Korea there are now 15 leading improved varieties. The areas where these varieties are grown with the acreage production data for 1947 are shown on the accompanying map (see figure 24). Brief descriptions of these varieties taken from the results of a 3-year test at the Sa Ri Won Agricultural Branch Station (1935-37) are shown in table 3.

The composition of improved varieties of Korean soybeans, on the basis of the size of the beans, is shown in table 4. These data were supplied by the Su Won Agricultural Experiment Station.

Climatic Relations

The climatic conditions in South Korea are somewhat similar to that part of the eastern seacoast of the United States which extends from Charleston, S. C., to Washington, D. C. An exception is a rainy season, July to August, and a winter season that is somewhat drier. Northern Korea is much colder, simulating the climate of southern New England. Rainfall varies from 40 to 50 inches over most of the country.

The prevailing winds blow from the Asiatic continent in winter and from the Pacific Ocean in summer, which results in combining continental and maritime climates.

Selected varieties of soybeans make satisfactory growth with well-filled pods throughout Korea proper and even on Cheju Do Island at latitude 34° N.

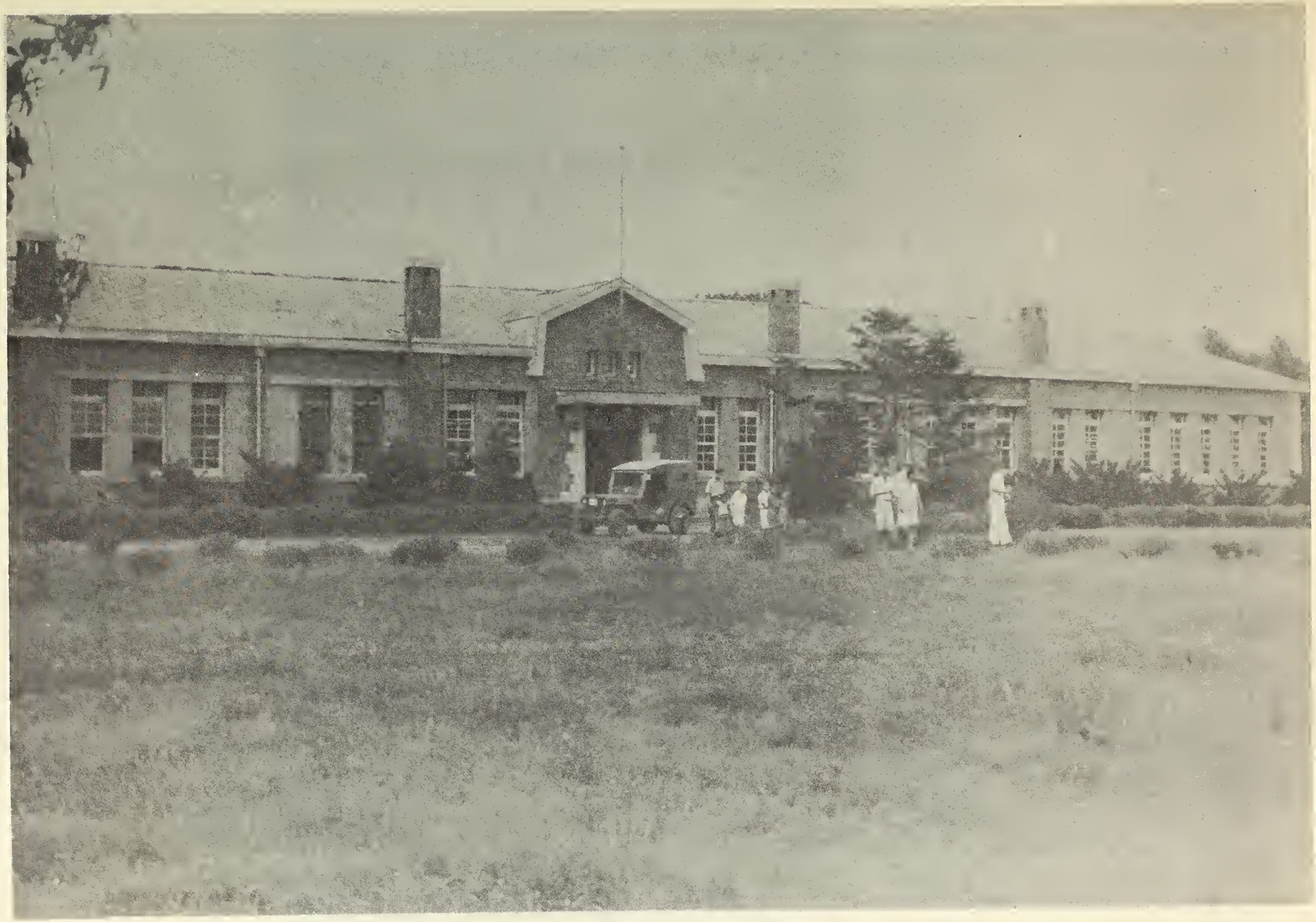


Figure 20.--Agricultural Experiment Station near Seoul. This station was built by the Japanese during their occupation of Korea. Later it was taken over and administered by the newly formed Korean Government. August 1948.

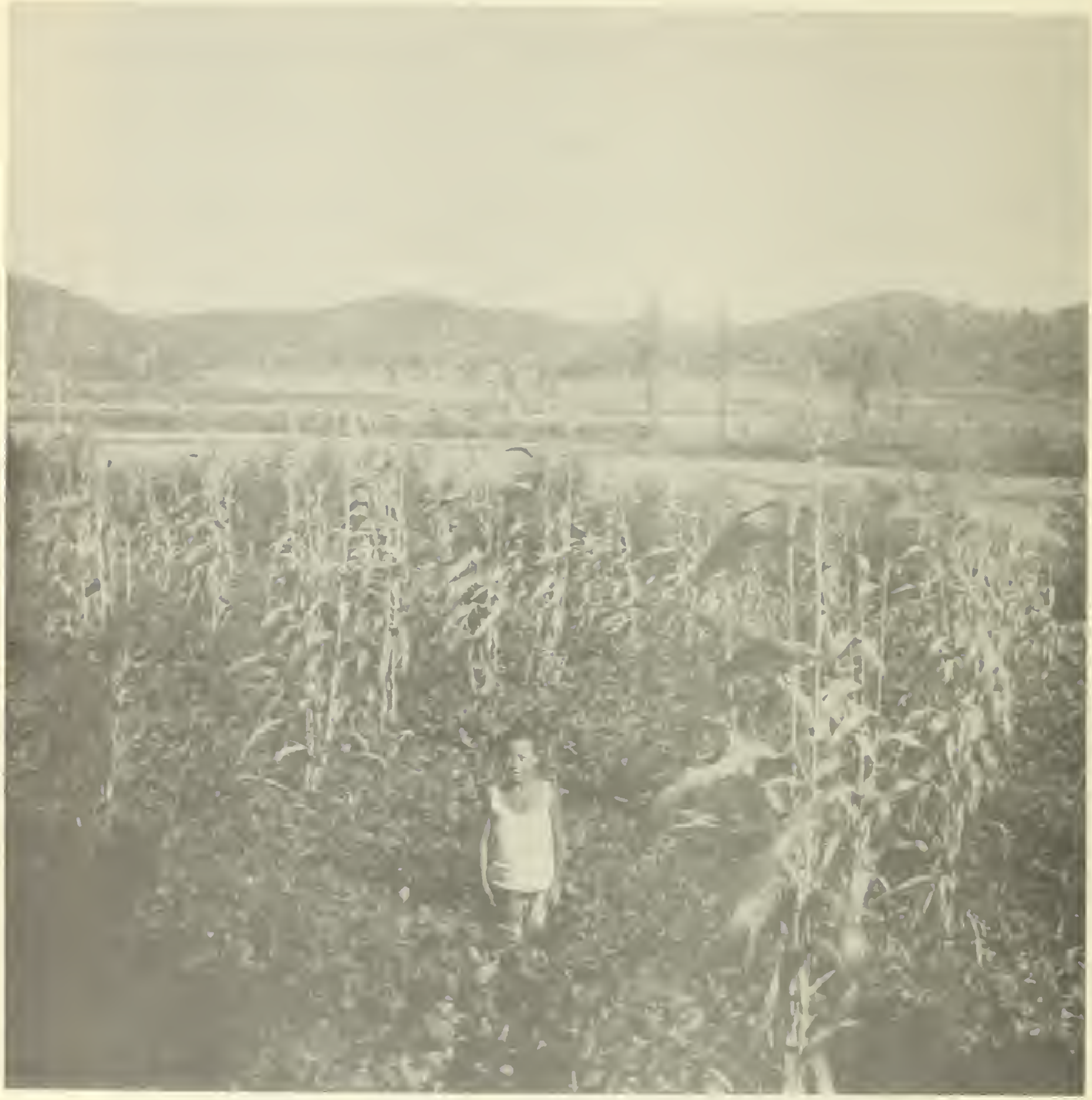


Figure 21.--The interplanting of sorghum with soybeans is a common practice in Korea. 1948.

Table 3.- The chief varieties of soybeans in Korea and descriptive data for each

Variety	Time of maturity	Color of flower	Length of stem	Color of grain	Weight of 1000 seeds	Yield per acre	Rank in test	Year approved
	Days		Inches		Grams	Bushels		
1. Chang Tan Paik	112	Purple	26	Light yellow or cream with yellow-brown hilum	253	32.1	3	1932
2. Chung Puk Paik	137	Purple	20	Cream with light brown hilum	209	24.0	12	
3. Chung Puk Whang	129	Purple	29	Yellow with brown hilum	209.4	32.1	4	1924
4. Paik Chom Kong	128	White	14	Light yellow with white hilum	145	24.8	11	1924
5. Paik Pam Kong	122	Purple	15	Yellow-white with yellow-white hilum	245	25.9	9	1939
6. Eik San	108	Purple	17	Cream to yellow yellow-white hilum	272.2	26.8	7	
7. Chuk Kok	116	Purple	30	Yellow with dark brown hilum	206.8	25.8	10	
8. Kum Du	113	White	25	Golden with brown hilum	178	[1]20.4	6	1921
9. Kyong Du	116	Purple	19	Light yellow with brown hilum	228	[1]30.5 per fy	5	1921

--Continued

Table 3.- The chief varieties of soybeans in Korea and descriptive data for each--continued

Variety	Time of maturity	Color of flower	Length of stem	Color of grain	Weight of 1000 seeds	Yield per acre	Rank in test	Year approved
	Days		Inches		Grams	Bushels		
10. Ham Am	109	Purple	13	Yellow with brown hilum	221.4	Very low	15	
11. Ul San	129	White	20	Yellow-green with brown hilum	180.4	[1]22.4	13	
12. Sen Chun	150	Purple	31	Yellow-brown with light-brown hilum	309	[1]14.3	14	1930
13. Kum Kang Toi	152	White	30 plus	Yellow to white with white hilum	426	[1]37.7	1	1931
14. Kum Kang So	143	Purple	44	Yellow-white with same color hilum	244	[1]36.8	2	
15. Chun An	128	Purple	14	Light-yellow with light brown hilum	231	[1]26.3	8	

Note: The following is an explanation of the Korean names for the soybean varieties listed: 1. Chang Tan--for a town in Korea and Paik, meaning white; 2. Chung Puk--for a province, and Paik, meaning white; 3. Chung Puk--for same province as 2 and Whang, meaning yellow; 4. Paik Chom Kong--literally, meaning white little soybean; 5. Paik Pam Kong--literally, meaning white chestnut soybean; 6. Eik San--for a town; 7. Chuk Kok--meaning unknown; 8. Kum Du--literally, gold soybean, "Du" being the Chinese name for soybean; 9. Kyong Du--provincial name; 10. Ham Am--town name; 11. Ul San--town name; 12. Sen Chun--town name; 13. Kum Kang Toi--Kum Kang from diamond mountain and Toi meaning large; 14. Kum Kang So--diamond mountains, large (So) beans; 15. Chun An--provincial name.

[1] Bushels per "fy"--per 1.1 acres.

Table 4.- Analytical data for improved varieties of soybeans on the basis of the size of the bean

Type of bean	Number of samples	Total nitrogen	Protein (N x 6.25)	Fat
		Percent	Percent	Percent
Large soybeans:				
Southeast Korea	2	6.73	42.18	20.67
Northeast Korea	8	6.88	43.17	20.55
Medium size soybeans:				
Southwest Korea	5	6.66	41.95	21.42
Central Korea	4	6.74	42.12	22.06
Northwest Korea	8	6.62	41.37	20.63
Southeast Korea	6	6.81	42.6	20.40
Northeast Korea	2	6.91	43.2	19.9
Small soybeans:				
South Korea	4	6.75	42.08	20.34
Central Korea	3	6.32	39.53	22.07
Northwest Korea	5	6.79	42.67	19.81
Northeast Korea	1	6.70	41.91	17.11

Note: Data supplied by the Su Won Agricultural Experiment Station. All calculations are on moisture-free basis.

Soils of Korea

The soils of Korea were formed in a temperate forest region and are derived from both igneous and sedimentary materials. Inland the soils are mainly of granitic origin, and the profile shows about the same composition where cuts are exposed. For the most part, the soils are somewhat acid and lack organic matter. Some of the best lands are those of alluvial nature along the rivers and ocean. Most of the paddy lands (rice is the principal crop) are underlaid with a hardpan which is excellent for holding water so essential for rice production.

Along the rivers and coast one finds sandy and gravelly loams; in the valley lowlands, clays and clay loams; and on the uplands, rather coarse sandy loams. When not trapped, the water drains off rapidly following rains. There are few springs or deep wells in Korea.

The system of land use does not include sod or pasture for resting the soil; hence, the soils are largely depleted of nitrogen. Two crops of grain each year, i.e., rice and barley or wheat, have been grown on the same land for years. The system of applying ashes from wood and other vegetable growth to the land maintains sufficient potash for ample plant growth on most of the soils.

To grow good crops the Koreans use as fertilizers night soil; compost made from grass combings, leaves, and waste products; leaves from trees; some animal manures; and commercial fertilizers which are principally ammonium nitrate and ammonium sulphate. Some superphosphate is used, but in general the value of phosphorus in crop production is not sufficiently appreciated.

Topography

Korea is a mountainous peninsula extending south from Manchuria and Siberia a distance of 525 miles. Its width varies from 125 to 200 miles and its area is calculated to be 85,000 square miles. Cheju Do Island, now considered a province, lies 50 miles to the southwest. On the east is the Japan Sea, on the south the Korean Strait, and on the west the Yellow Sea.

The relief pattern is characterized by (1) a mass of mountains in the north, (2) a long range of mountains extending from north to south along the east coast, and (3) a series of ranges extending southwesterly from the eastern mountains. Seven principal rivers flow to the west and the best lands are along these rivers, principally in the southwestern part of the country. Most of the farm lands lie south of the 38th parallel, but even here, arable land represents only about 25 percent of the area. Cross-country travel is difficult. Good all-weather roads are few. It was once the custom to take up the bridges during the rainy season so as to have them in the dry season. Otherwise they would wash out.

In general, the vegetative cover on the hill and mountain lands is sparse, a result of indiscriminately cutting the forests for timber and fuel, and literally combing off of the grasses for compost as well as for fuel. Naturally, erosion is very serious and an aerial view presents a series of bald spots and muddy streams covering the landscape.

Land Use

The pattern of land in Korea is very interesting. The average size of farm is 2.7 acres, and all land suitable for rice is planted to this crop during the summer months. The numerous small paddies are separated by low dikes or banks which serve to separate the land holdings and to trap the water necessary for growing rice. Where the climate permits, which is in about two-thirds of the country, barley to a major degree, and rye, wheat, etc., are used as a winter double crop on the rice land. On the uplands, which lack sufficient natural or irrigation water to grow rice, small grains are grown in the winter, followed in the summer and fall months by soybeans, sesame, sorghum, millet, peppers, puerilla, cotton, Chinese cabbage, radishes, and other crops required for family use. It is customary to plant a few rows or a bed of each crop (rice excepted), placing the rows far enough apart to permit interplanting of another crop before the first matures. Blocks of soybeans may be planted, but frequently the beans are used as border plantings on the dikes, around patches of sesame, puerilla, peppers, and other vegetables. Plantings of soybeans are found under many conditions, along railroad and road banks, on both new lands and those which have been under cultivation for centuries. In some sections scattered seedings of soybeans are made in millet, while in others scattered plantings of sorghum or row plantings with the plants several feet apart are made in the soybeans as shown in figure 21. Many orchard men use soybeans as a cover crop and plow the crop under for green manure. Soybeans are seldom employed as a cover crop, however, other than in the orchard.

Cultural Practices

Soil Preparation.- The larger areas are plowed with an ox hitched to a very simple steel-pointed plow. Smaller lands are dug up with crude hoes or shovels, many of which are three-manned. This three-man shovel, which is shown in figure 2, always creates a great deal of interest among foreigners. The shovel blade has holes at the side to which long ropes are attached. One man guides the shovel by means of a long handle, while two men, one on each side, manipulate the ropes, pulling the shovel full of soil while the man on the handle directs its movement. The soil is leveled with rakes, and large lumps are broken with mallets. Sometimes the land is "boarded down" but usually the seedbed is left loose. For interplanting in winter grain, a row must be made with a hoe, since the soil is rather firm from walking between the rows.

Method of Seeding.- Seeding is done by hand and both hill and row planting is practiced. In hill planting, the hills of 2 to 3 seeds are spaced 12 inches apart in the row, while in row planting, which corresponds to our drilling, the seeds are spaced singly 4 to 5 inches apart, with from 30 to 40 inches between rows. Methods differ, just as elsewhere, and vary according to the whims of the planters. Usually, after the farmer drops the seed he tramps it in with his heel.

Time and Rate of Seeding.- Seeding time for soybeans ranges from early May to late June, depending upon the variety, climatic conditions, and system of cropping. As shown under varieties (table 3), maturation periods range from 109 to 152 days, so this must be considered with the seeding time, although the maturing time of the previous crop probably determines seeding time more than any other factor. The common rate of seeding is 15 pounds per tan (1/4 acre), the usual seeding unit.

Since soybeans have been grown for centuries, inoculation of the seed is not necessary. Examination of roots of plants throughout Korea showed plenty of nodules.

Fertilizer Used.- In the past a 0-4-4 fertilizer was recommended for soybeans. However, in 1948, commercial fertilizer use usually was limited to superphosphate, with the potash being derived from wood ashes. Animal manures, compost, and night soil (see figure 22) are applied when available but usually to the grain or vegetable crop preceding the soybeans.

Cultivation.- Cultivation is done manually, with regular long-handled Korean hoes or small, curved scraping hoes which are usually wielded by women who "waddle" down the rows in groups as they weed and hoe. This weeding custom creates something akin to a social gathering and frequently two to a dozen or more women can be found in one field. For some reason, men are seldom found weeding soybeans. Their time is spent in the rice paddy. Most of the farm patches are too small for the efficient use of machinery even if it were available. It is a hand-proposition from start to finish.

Harvesting and Threshing.- When beans are to be sold while still green, they are pulled from the ground, bunched, and taken to market. Mature beans are cut off at the ground with hand sickles, bunched and set up to dry in the field or carried to the buildings and hung up to dry under the eaves.

Whenever needed, which is mainly during November, December, and January, the beans are placed out on a level area, also used for threshing grain, and the seeds are flailed out. The leaves are collected for livestock feed and the stems are saved for fuel. Occasionally, the beans are tramped out by horses or oxen as the animals are driven in circles over the material, but this is not a common practice.

Marketing

It is estimated that 60 percent of the soybeans harvested are marketed and that 40 percent are consumed on the farm. Figure 23 shows a common method of displaying soybeans at a market in Seoul. Although soybeans are sold throughout the year, most of the beans are marketed during January, February, and March, the season for making soya sauce, paste, and cochinchang (kochuchang). Because of the constant market for curd and other products, making them is a steadier and less of a seasonal job.

Soybeans as Foodstuff

In direct human consumption, soybeans play an important part in the diet of the Korean people. To make the beans, which are all classed as edible, as palatable as possible, many methods of preparation have been devised. In addition to whole cooked beans, products include soya sauce, bean curd, bean paste, bean milk, bean flour, bean sprouts, stewed beans, bean cake, and bean cheese.

Soy Sauce

Soy sauce is found on the tables of all Koreans, where it is used quite generally on rice, sukiaki, fish, chicken, and other meats and for the flavor it adds to soup. It is a very popular appetizer. Most families make soy sauce and are allocated 2.7 kilograms of salt per person annually for this purpose. Yearly consumption is about 6 sung per person. In addition to homemade soy sauce, a supply is also available from many small factories making it. There are more than 10 plants in Seoul, the capital city.

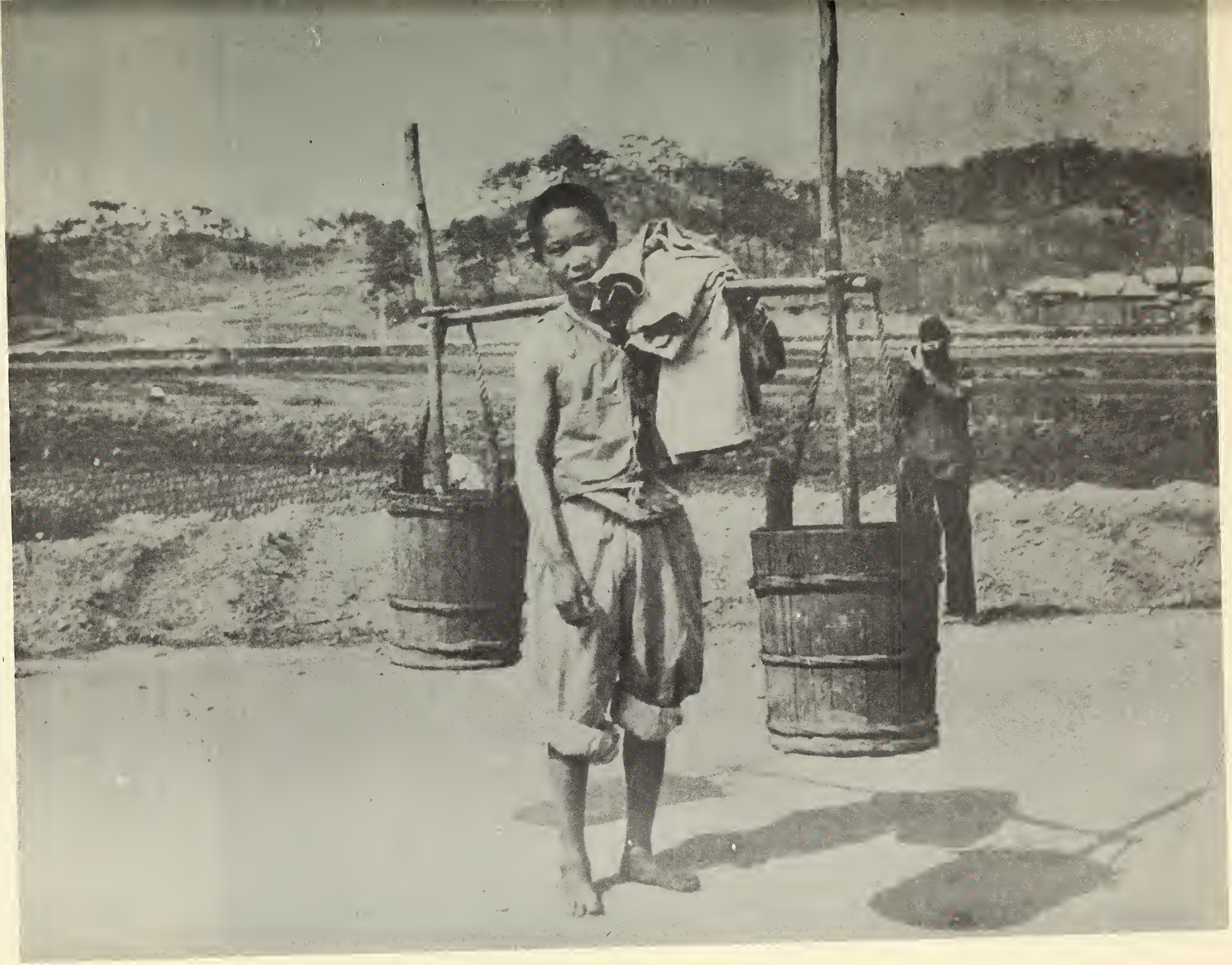


Figure 22.--Wooden buckets are used for conveying night soil to the land. Korea. 1948.

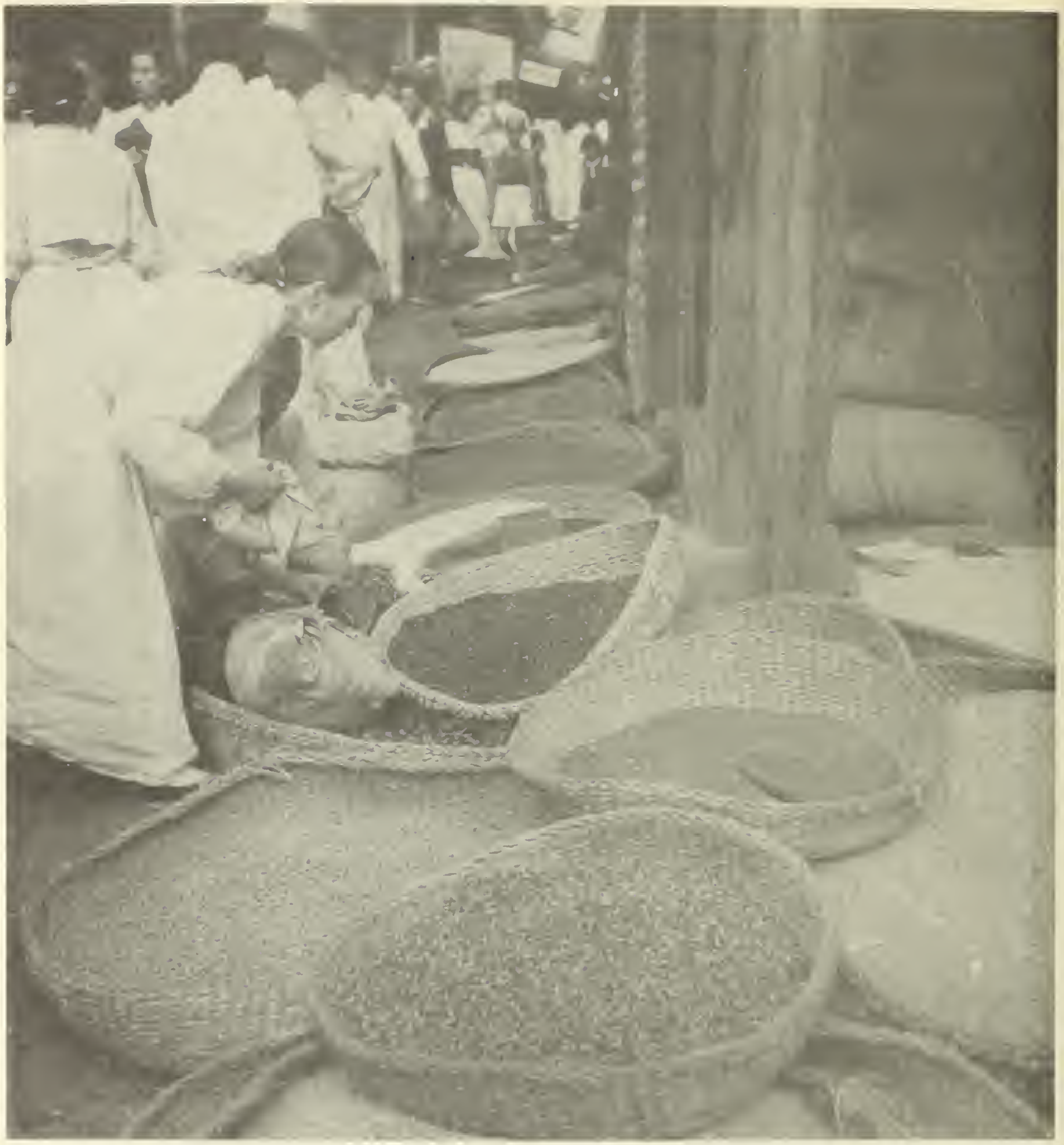


Figure 23.--A woman shopper looking over the different varieties of soybeans in the market place at Seoul, Korea. August 1948.

Making soy sauce in the Korean home starts about January or February. It is the custom at this time to take a batch of beans and boil them in water until soft, following which they are mashed and formed into a ball, placed in a rice-straw bag and hung up in a heated room to ferment for a 3-month period. Following fermentation, the ball is cut open, broken into pieces and allowed to dry in the sun. When dry, water and salt are added, inoculant (yeast) introduced and the mixture allowed to stand in an earthen crock 2 to 3 months. The liquid is then poured off, boiled about 2 hours and filtered, following which it is considered to be sauce. The sediment remaining in the crock is known as paste. This is used primarily for making soup. In both home and commercial production of soy sauce, parched and browned wheat or barley is frequently used in conjunction with the soybeans.

Green Pods on the Bush

It is common practice to market early beans on the bush. The plants are pulled, the dirt shaken from the roots and the leaves removed. The branches are tied with a string (usually hemp) and the plants are taken to market where they are sold by the bunch. The housewife prepares them for eating by picking off the pods and boiling, and the plant stem is used as fuel.

Bean Sprouts

Bean sprouts (see figure 6) are much in demand, especially during the winter months. They are used in combination with meat, Chinese cabbage, spinach, turnips, soups, and various other cooked dishes. Sprouts are nourishing and supply much-needed vitamins to the Korean's usual diet of polished rice. In some instances the beans are left on the sprouts, in others they are removed. The beans are sprouted in central places and usually peddled in two-wheeled, man-drawn carts. Sprouting requires about a week. They are sold on a weight basis.

Parched Beans

For parching, soybeans are simply placed in a pan over a fire and heated slowly until the skin breaks and part of the bean is slightly blackened. They are eaten like peanuts or mixed with other foods. Most varieties are quite palatable and well liked for parching.

Soybean Curd and Soybean Milk

Soybean milk is consumed in Korea, but not so extensively as in China. The milk is made in a manner similar to the Chinese method which is described in Part I.

A large percentage of the soybeans grown in Korea are consumed as soybean curd. In addition to the huge quantities made at home, curd is also made in literally hundreds of small factories. In Seoul alone there are more than a hundred. Small units, which on the average employ 5 men, can work up about 10 bushels of soybeans daily. The beans are soaked in water for several hours, then crushed and boiled until of milk consistency. The curd is precipitated by adding rennet, then collected by filtering. It is then placed in wooden frames and pressed or allowed to set, and then cut into squares which resemble old-fashioned cakes of soap. The general practice is to operate the curd factories, which are usually of one vat capacity, at night and to distribute the product at the various markets in the morning. At present these cakes sell for 15 won (about 5 cents, U. S. money) each. The curd, after boiling, may be used "as is," or in soups or with fish or other dishes like Sukiaki, which is a conglomerate of many ingredients such as meat, bean sprouts, onions, and cabbage.

Kochuchang

Practically every Korean family makes kochuchang. Boiled beans are mashed and hung up in sacks to cure well for 2 or 3 months. This material is then broken up, dried in the sun, and ground to a fine powder, usually in an old type hand-operated stone mill. Red peppers are ground fine, the lot is mixed and salt and water added, then it is allowed to stand in crocks 2 to 3 months. To prepare kochuchang for the table, it is taken from the crock and boiled with the addition of ground meat and sugar, if the latter is available.

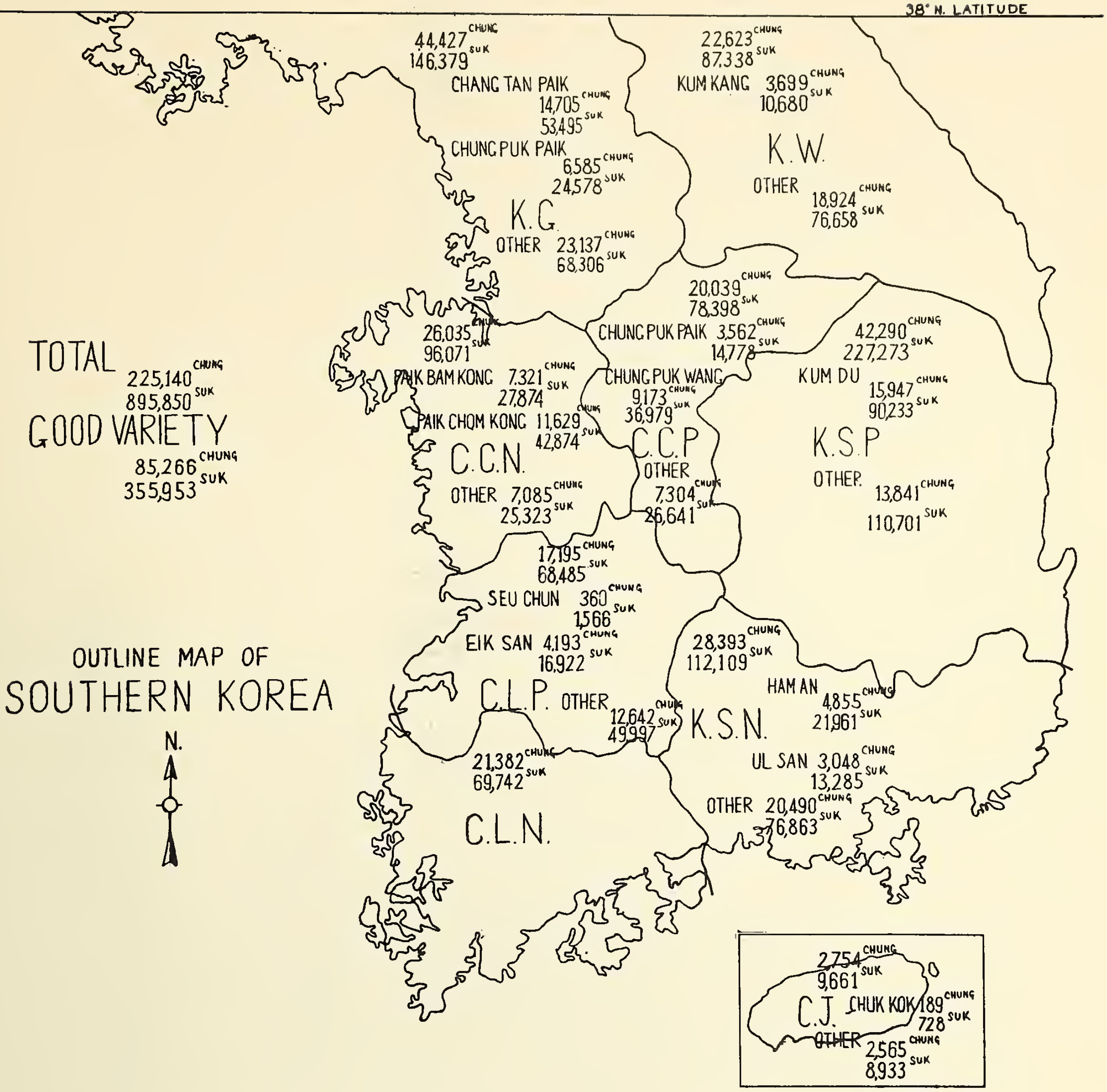
Other Uses

Green Manure.- Soybeans are seldom used as a green manure crop in Korea. A few instances were observed in orchards and on the Island of Cheju Do on some hill land. The beans are grown quite generally in orchards but are usually harvested for food rather than turned under for manure. The demand for food is too great to permit extensive use. In Korea, hairy and Chinese vetch are the green manure crops rather than soybeans.

Soybeans as Livestock Feed.- Soybeans form the principal source of protein in livestock feeding. They are fed liberally to working cattle, milk cows, horses, and rabbits. To a lesser degree they are fed to hogs; usually for a few days following farrowing.

The Koreans produce few cattle for beef, and the term "work cattle" is employed. Work cattle supply the power other than man power of the country, and are used for work on the farm as well as for pack and dray animals. The cattle are worked hard and require plenty of feed although seldom getting a balanced ration. During the heavy work season it is common practice to feed working cattle 1 to 2 quarts of soybeans daily. The cattle feed is prepared by mixing the beans with rice straw, soybean or other hay, and rice bran, and cooking the mixture in water.

For horses at work, about 1 quart of soybeans daily are soaked in water and fed along with rice bran, rice straw (cut up) and oats, if available. Some soybean hay may be fed also.


38° N. LATITUDE
OUTLINE MAP OF SOUTHERN KOREA
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TOTAL 225,140 CHUNG 895,850 SUK
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CHUNG PUK PAIK 6,585 CHUNG 24,578 SUK
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C.C.P
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PAIK BAM KONG 7,321 CHUNG 27,874 SUK
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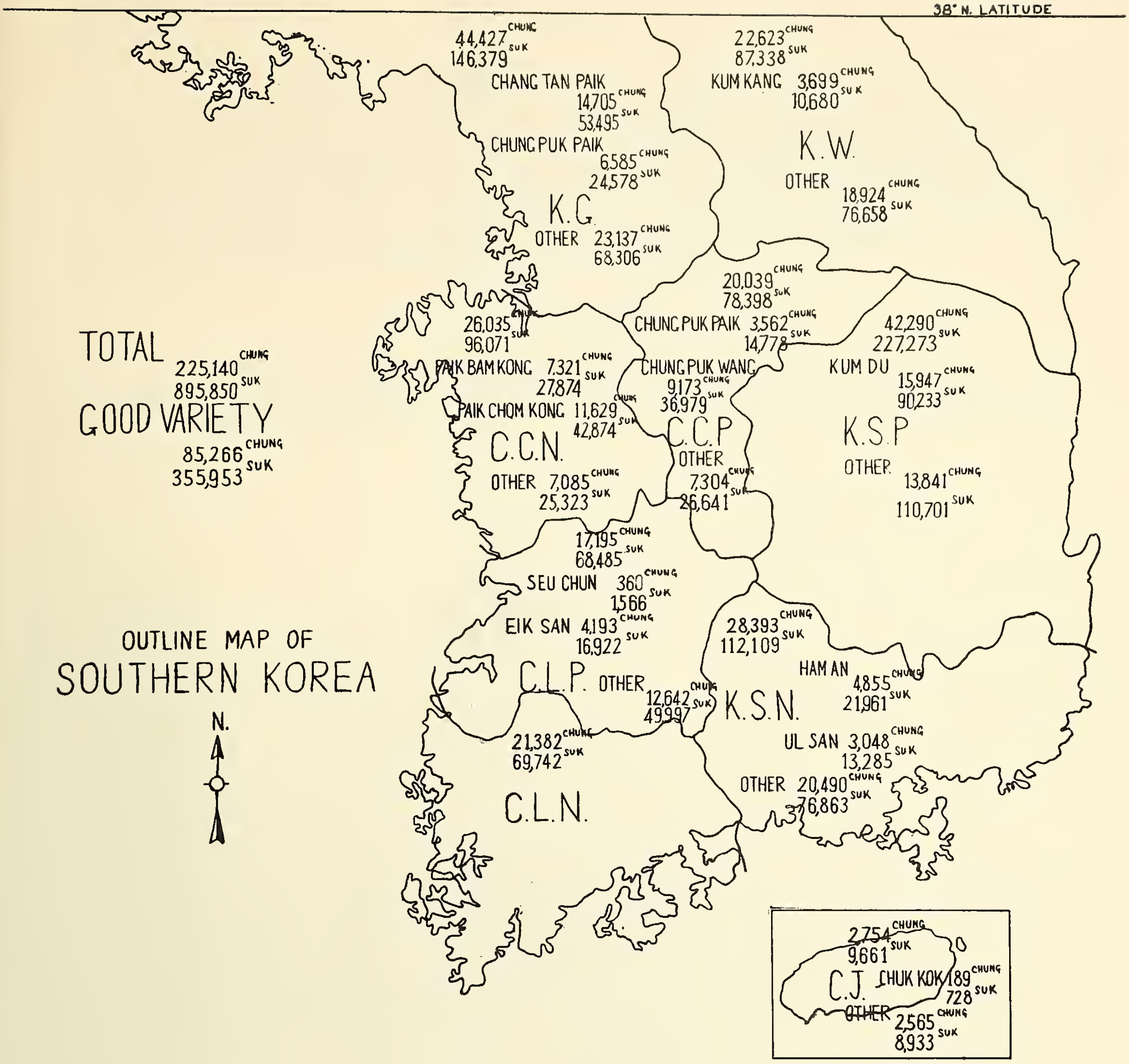
Figure 24.--Outline map of South Korea showing where principal varieties of soybeans are grown, the section in which each variety is found, the acreage, and production. A chung or chungbo is 2.45 acres, and a suk is 5 bushels. The yields appear very low, a result of the custom of interplanting soybeans with other crops. Map furnished by Korean Department of Agriculture, and courtesy of United States agricultural advisers in Korea. 1948.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Dairy cows are usually fed 1 to 2 quarts of soybeans daily in addition to considerable soybean hay during the lactation period. The beans are soaked in water before feeding. Prior to the war, soybean cake was brought in from Manchuria and was a part of most livestock rations. With Manchuria under Russian domination at the time this was written, soybean cake was no longer available. The extraction of soybean oil has never been of commercial importance in South Korea.

Acknowledgment

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